Boat Design Deriving from Ethnographic Study: A Transdisciplinary Approach to Malaysian Fishing Boat Design

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ABSTRACT

Boat Design Deriving from Ethnographic Study: A Transdisciplinary Approach to Malaysian Fishing Boat Design

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The goal of the project is to further the positivist discourse of design by ascertaining whether ethnographic analysis contributes to the design process. To this end, the project provides 1) a culturally appropriate conceptual fishing boat design and 2) an industrial design case study.

This project identifies mechanistic and non-mechanistic design elements and presents the results of thematic analysis. This project develops a 40 GRT (gross register ton), Malaysian Class B fishing boat design based primarily upon ethnographic study of stakeholders, which includes fishermen, boat builders, designers and owners. The design concept is evaluated by fishermen regarding perceived performance as a fishing boat, aesthetics, safety, and comfort. The concept boat is compared with the visual stereotype of a traditional Malaysian fishing boat and a Western style, deck forward design. The conceptual design is evaluated with a creative product analysis matrix (CPAM) followed by a questionnaire based evaluation by fishermen.

This project is intended for students and practitioners of industrial design interested in culturally appropriate design. It provides insights into design methodology and ethnographic methods for developing an understanding of indigenous design sensitivities of a client or end user. This study provides an example of product development that integrates the designer's creativity with the stakeholders' requirements and material culture. This project also demonstrates the technique of superimposing photographs via computer aided design (CAD) drawings to develop a visual stereotype. Moreover, this project demonstrates the benefit of employing visual models in charcoal and clay in ethnographic fieldwork.

Key Words: industrial design, ethnography, fishing boat, Malaysia, traditional design

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GLOSSARY AND ABBREVIATIUONS

The geography of Malaysia can be conveniently divided between the east and west coast, with the east coast facing the South China Sea and the west coast facing the Strait of Malacca. Both references are used in this study. Traditional boat builders are also the boat designers so this connection is preserved in referring to them as 'boat designers/builders'. The term 'fishermen' includes only those professionally crewing traditional Malaysian fishing boats.

I have strived to avoid idiomatic maritime terminology when a suitable substitute is available, for example, substituting 'high sea state' instead of 'heavy seas' or 'heavy weather.' However some terms are unique to the maritime world and even vague in their definition. For example seakindliness is comfortable boat behavior at sea and describes a boat that is easy on its crew in terms of how it behaves to conditions. This normally means the boat has a rolling behavior that is physiologically more comfortable than an abrupt rolling. Some terms are defined as they arise; however, the following terms are important in this study:

Glossary

Abaft:	Toward the stern or back of a boat.
Athwartship:	Across the boat transversely, from side to side.
Beam:	Width of boat at widest point.
Bow rake:	The angle of the boat's stem.
Bulwark:	Extension of hull above deck, providing a solid rail around portions of the boat.
Class B:	Licensed category of fishing boat built under 40 gross register tonnage (GRT) and limited to offshore fishing in Zone B, which ranges from 5 to 12 nautical miles from

shore. During monsoon season the boats can apply for an additional license that allows them to operate within 5 nautical miles for prawn.

Deadrise Angle: Angle of boat bottom relative to horizontal. A flat bottom has a 0 degree deadrise angle.

Deckhouse: Enclosed structure on top of deck. See also pilothouse.

Freeboard: Hull height above water, specifically length from waterline to sheer line.

Freeing Ports: Openings in the bulwarks at deck level that allows water to drain off the deck.

Green Water: The usage is nautical rather than maritime geography and indicates water (not spray) from the sea coming onboard as when a wave breaks on the deck. This occurrence is also called 'shipping of water'.

Lines Drawing: Drawing of boat with lines providing references to the shape. In this project the lines drawings include the half breadth plan and the body plan

Pilothouse: A structure dedicated to the helm controls.

Seakindliness: Comfortable boat behavior at sea.

Sea State: Description of sea surface roughness. A number is associated with a sea state and a 'high' sea state indicates big waves.

Sheer Line: The fore and aft (longitudinal) curve along the top of the hull. Sometimes referred to simply as sheer.

Through hull: Valve assembly specifically designed to penetrate through the hull. Used for allowing fluids to pass in or out of hull.

Trunnel: Wooden dowel used to fasten planks.

Tumblehome: Inward slope of the deckhouse.

Abbreviations and Acronyms

CPAM	Creative Product Analysis Matrix
EPIRB	Emergency Position Indicating Radiobeacon
EU	European Union
FRP	Fiber Reinforced Plastic
IMO	International Maritime Organization
MOB pole	Man Overboard pole
PFD	Personal Floatation Device
UTM	Universiti Teknologi Malaysia

Technical

B	Beam
B/T	Beam to Draft Ratio
BWL	Beam at waterline, maximum
C_B	Block coefficient
C_p	Prismatic coefficient
Fr	Froude Number (Fr)
GRT	Gross Register Tonnage (Malaysian rules)
HP	Horsepower (equivalent to 1.34 kW)
L	Length
L/B	Length to Beam Ratio
$L/\nabla^{1/3}$	Length to Displacement Ratio
LOA	Length overall
LWL	Length at waterline
S/L	Speed to Length Ratio
T	Draft
∇	Volumetric Displacement

PREFACE

Why Malaysian Boats?

"Mystery creates wonder and wonder is the basis of man's desire to understand."

(Neil Armstrong)

Selecting a research site calls upon an admixture of sagacity, imagination and optimism. Because I wanted to study the effects of mechanistic and non-mechanistic forces, I sought a site where both ancient traditions and modern methods tugged on the design culture. I selected boats as a representative product suitable for anthropological approaches in industrial design and desired a culture that had an ancient maritime tradition where rapid modernization was introducing contemporary engineering principles into many applications. I felt Southeast Asia was exemplary in meeting these criteria because it had one of the fastest growing economies in the world while still building traditional wooden craft for offshore fishing.

Other experiences pointed towards this region: while researching boats in the early 1990s I came across Horridge's monograph and OSS (Office of Strategic Services) reports from World War II that intrigued me with their descriptions of dramatically designed boats with fanciful lines. On a trip to Malaysia in 1995, I visited the boatbuilding community at Kuala Terengganu. This community interested me because these artisans were building beautiful, traditional boats while at the same time Malaysia's offshore oil industry was purchasing contemporary, steel offshore supply vessels. Additionally, I noted the aesthetic differences between Malaysian (and Indonesian) boats and other Southeast Asian boats.

However, intrigue was not the only motivator for selecting Malaysia as a research site. I was equally intrigued by Indonesian harbors jammed with the piercing bowsprits of *pinisi* schooners, India's delicate *oru* outriggers, Tanzania's rough hewn *dhows* and Norway's golden hued *snekkes,* to name a few. All of these regions would have provided attractive research sites; however, while my site selection had a serendipitous aspect, Malaysia provided the best combination of features for my study of non-mechanistic forces arising in this ancient culture infused by external influences and modernization. Malaysia has strong indicators of modernization, being ranked 57th in the United Nations Development Programme's 2010 Human Development Index (UNDP 2010). This index measures development by combining indicators of life expectancy, educational attainment and income. The only Asian nations exceeding Malaysia's Human Development Index were Japan, Republic of (South) Korea, Hong Kong (China), Singapore, and Brunei Darussalam. Malaysia was also ranked 21st is 2008-2009 Global Competitiveness Index ratings of the World Economic Forum (World Economic Forum 2008). This index is a broad measure of the business environment, including macroeconomic measures, infrastructure, education, and technological readiness. The only Asian nations exceeding Malaysia were Singapore, Hong Kong (China), and Republic of China (Taiwan). Peninsular Malaysia also had the practical appeal of allowing me to efficiently investigate a specific geographic area and one in which I had some prior experience.

After selecting Malaysia as a research site, I was fortunate in obtaining an appointment as a visiting professor in the faculty of mechanical engineering, maritime technology department at the Universiti Teknologi Malaysia. This appointment provided a platform for my work, logistical support, and the opportunity to dialogue with Malaysian scholars.

CHAPTER 1

INTRODUCTION

Entering my professional career, I quickly learned that designing something new was very stressful because I did not know where to start. Every idea seemed so arbitrary, every approach contrived, like the whimsical product of a childhood art class rather than a methodical design. There was stress in all of this ambiguity. The development of the initial design concept did not involve a linear progression but a chaotic meshing, merging, and metamorphosing of many factors followed by some arbitrary leaps of faith. However, after the design concept was agreed upon, a more orderly progression of technical developments could occur.

The design process is typically initiated with a clear articulation of design requirements. Following the establishment of these requirements is the concept development which is then engineered into a finished design. Both technical and business issues provide basic design direction such as performance, durability, and costs. Additionally, regulatory forces, such as safety standards, provide a baseline for design conception while corporate attitudes toward environmental factors and manufacturing preferences moderate design approaches.

The chaotic process of concept development has many interesting layers but I have always been impressed at how important initial design concepts were in executing a successful commercialized design. As I gained more design experience, I recognized that many ambiguous factors are introduced into the design process. I observed more experienced designers and recognized that the initial concepts were developed quickly compared to the design details that consumed the bulk of design time. While design details are important in ensuring a product's functionality and durability, the initial design concepts are often weakly rooted in science and strongly in the realm of 'something else', the identification of which intrigued me.

Because design is done by (and usually for) humans, a long list of non-mechanistic factors is introduced into the development of designs, ranging from the sociological forces of group identity and organizational behavior to individual egos and ethics. Aesthetics also assert a subliminal force, even on machinery and other non-consumer designs. These intangible forces that enter into the design process have become my main area of interest.

Commercial product and system designs are dictated by some perceived marketing force, either by quantified studies or the intuition of the entrepreneur. Large corporations will identify a product need by their marketing studies while small companies and entrepreneurs may identify a need by observing the marketplace and using their own judgment to identify a need. Design concerns quickly move from the technical world to the broader world of business. Although the relationship between technical demands and business interest are well understood, the subliminal forces acting upon the designer are less obvious – corporate culture mingles with the designer's biases, prejudices, aesthetic senses, and ethics in order to produce blended approaches to design. Tradition and other social forces such as group identity and cognitive dissonance also loom in a designer's mind.

Traditionally, design requires technical skills and experience to ensure the product or system works in the way it is intended. Therefore, design is left to design professionals such as engineers, architects and naval architects. However, less obvious, intangible design inputs become integrated and direct the final form of the design. These sometimes subliminal forces can be brought to light through an ethnographically founded transdisciplinary study such as occurs in this project.

Currently I straddle two professions, one as a practicing designer and the other as an educator. As a designer, I create new products and systems and draw upon my experience to develop designs that specifically meet customer expectations rather than ones that are simply functional and self-expressive. As an educator, I parse the design process into manageable portions. This is a challenge because many design elements are difficult to articulate, such as the importance of tradition and aesthetics.

My evolving interest in design motivated me to study and contribute to the industrial design discipline. Industrial design requires designers to understand client goals, markets, and preferences. Once these considerations are identified, the designer can contribute both technical and aesthetic elements; however, the design profession is not only one of self-expression, but rather one more often wrought with empathy. *Empathic design* is an approach to product or system design in which the designer not only tries to fully understand the end user requirements, but also the cultural and social forces connected with the end user. The designer strives to develop empathy for the end user that allows the designer to integrate a broad range of product or system features that may be attractive to the user. Specifically, this project employs a transdisciplinary approach to design that allows for a better understanding of both mechanistic and non-mechanistic requirements.

By way of introducing my positionality, discussed later in Chapter 2, I consider this study to be a logical extension of my design career. My professional career has largely been focused on design engineering, while my academic progress has moved from technical to sociological and psychological perspectives. My undergraduate degree is in mechanical engineering with an emphasis on analysis, my graduate studies focused on organizational behavior with my MA thesis focusing on organizational behavior on advanced airplane and marine designs. This DProf project entailed an anthropological perspective of design that looks beyond group forces and organizational behavior. I believe this broadening perspective, from mathematical, to group behavior, to cultural behavior is a logical progression of study. Moreover, it complements my professional experience, which has followed the same path. A young engineer learns quickly that “other” forces enter the design. Financial concerns are usually the first non-engineering motivator of design; however, customer perception, aesthetics, brand fit and cultural appropriateness all become important elements. This is particularly true for internationally oriented products or those products geared to markets much different from the designers own experience, such as mentally and physically disadvantaged people, old and young people, opposite gender and unique applications.

Project Overview

The goal of this project is to ascertain whether ethnographic approaches are viable in the creative design process and thereby extend the positivist discourse of design. This extension of professional practice is demonstrated in the form of a concept fishing boat design and a case study for industrial design students. Other project outcomes include a lines drawing of a traditional fishing boat, pending publication of the thematic analysis in an academic journal , the dissemination of the design feature questionnaire results to the Malaysia’s Department of Fisheries, identifying and employing a visual stereotype as a component of design methodology and as an archetype to ‘bracket’ the concept boat evaluation, using clay modeling as an adjunct to interviews, and providing suggestions for reducing chengal (*neobalanocarpus heimii*) wood consumption.

Boat design is greatly influenced by non-mechanistic considerations. These are design elements that do not directly affect the boat’s function but are important to the stakeholders. These non-mechanistic features can range from purely aesthetic, such as color schemes and enticing forms, to markings that promote safety. Identifying non-mechanistic design considerations are important for developing a culturally appropriate design. As a design topic, boats offer a unique opportunity to explore the interplay between competing mechanistic and non-mechanistic requirements, such as performance and aesthetic, stability and capacity, comfort and seakeeping, safety and speed.

This project uses ethnographic methods, specifically interviews, observations, and questionnaires in order to develop a fishing boat acceptable to stakeholders, namely Class B boat owners, designers/builders and fishermen. These stakeholders are interviewed and observed to gain input on an ideal Class B boat design, considering both mechanistic and non-mechanistic attributes. Clay models and drawings are used to aid in my investigation. These media minimized miscommunications in the feedback process.

At the least, boats require specific functional attributes such as stability, load capacity, maneuverability, and seakindliness (i.e. the motion of a boat while moving through water). To achieve these goals, the most important aspect of a boat is its hull design. For instance, underwater form dictates factors such as speed (e.g. planning versus non-planing hulls), ability to travel in shallow water, and seakindliness, while the above waterline form should accommodate a specific fishing task, such as an open transom or low freeboard (height above the waterline) sections. Finally, the deckhouse (or superstructure) must accommodate crew needs that on small boats, normally consists of a pilothouse (or wheel house) that provides a protected enclosure for the helmsman.

A positivist ontology, which prevails in the applied sciences where I have long sought refuge, cannot discern Heidegger's question of "why there is something rather than nothing." Mathematics, particularly statistics can suggest accuracy in data that is completely undeserving of such treatment. Bracketed by philosophical uncertainties and the limits of quantification, qualitative methods present data and perspectives that benefit the pseudo-technical discipline of industrial design. However, this uplifting of ethnography as an instrument of design does not suppress the importance of engineering in design. The rigors of stress, fatigue and impact analysis as well as the dynamics of stability and seakeeping are vital for good design. All of these analyses are underpinned by the science of fluid mechanics, mechanics of materials and to a lesser extent thermodynamics and heat transfer.

Malaysia

The richness of the maritime tradition in Southeast Asia is difficult to equal anywhere in the world. With large populations and ready access to the sea, the vessels which allowed populations to harvest the sea's bounty have an important history. Peninsular Malaysia was influenced by Proto-Malays, Indians, Arabs, Chinese, Sumatrans, Javanese, Portuguese, Dutch and British. Northeastern peninsular Malaysia was influenced by Thailand and was governed by Thailand until 1909.

Due to the Malaysian peninsula being the southernmost projection of continental Asia and a subsequent obstacle to sea trade, peninsular Malaysia became subject to the trading histories of great civilizations to the west and east, from Indian, Arabic, and European to the west and Chinese to the east. Peninsular Malaysia is referred to in many ancient texts and archeological finds connecting the region to sea trade, most prominently as the southern trade route between China and Indian subcontinent. While design influences arising from trade came from the west and east, the dominating cultural influence came from the south and north with Sumatran, Javanese and Thai cultures controlling portions of peninsular Malaysia until the arrival of the Portuguese, Dutch and British.

Although I have visited many boatbuilding communities in the last twenty five years, my 1995 visit to the boatbuilding community in Kuala Terengganu motivated this study. This community was especially interesting because the boat builders were (and continue to be) immersed in one of the fastest growing Asian economies and an offshore oil industry that uses modern technology, including Western style support vessels docked at their very doorstep.

The Malay civilization is ancient yet has encountered powerful influencing factors from nearby and distant cultures as well as the hegemony of Islam and large 19th century immigrations from China and India. In the last thirty years modernization has rapidly overtaken Malaysia fed, in part, by oil revenues. Fishing communities have more recently been affected by the government's inducing fishermen to seek employment in other sectors as a means to reduce poverty among fishermen. These economic changes present a further layer of intriguing dynamism for ethnographic study of boat design.

The traditional wooden Malaysian fishing boat connects the present with the past, from regionally sourced wood to long adopted construction techniques. This perpetuation of tradition is unique in comparison to Western fishing boats where, in the last century, new materials and designs were quickly adopted and expanded through fishing fleets. While Malaysia has many sectors fully embracing modern technology, the fishing industry continues to rely on traditional craft that are motivated by Malaysian culture and economics.

Photo 1.1. Anchor handling tug/supply vessel docked at Kuala Terengganu.

Project Approach

Data is obtained through ethnographic methods (interviews, observations and questionnaires) and a visual stereotype (for the sheer line and proportions). With this data, design attributes are integrated into the conceptual design of a Class B boat. A new group of Malaysian fishermen then respond to a questionnaire to evaluate the acceptability of the concept design. The questionnaire is accompanied by outline drawings and clay models of 1) the conceptual boat design, 2) the visual stereotype and 3) a Western style, deck forward design.

Relationship with Previous Learning

This project flows from my RAL Level 8 claims related to commercialized designs and project management. These experiences acted as a springboard for this project because they demonstrated my ability to create innovative, patented designs that were commercially successful as well as my ability to manage complex projects. This project advances the professional practice of design by employing transdisciplinary methods that separate the mechanistic forces from the traditional, cultural and societal forces acting on the design process. I think it would be difficult for someone without these RAL claims to identify and separate mechanistic and non-mechanistic design elements in an ethnographic study because one must often interpret data as it arises and immediately reformulate approaches in response to the data. This foundational experience presented in the RAL claims constituted a first volume of contribution to professional practice and allowed me to progress to this second volume in the form of the project described herein.

Project Connection with Professional Practice

The industrial design discipline is focused on recognizing a client's design goals after a period of study and discernment. The designer is compelled to go beyond the design brief that enumerates specific requirements or goals. The designer needs to understand the product's intended use, the context in which the product is employed, the end-user's values, how it can be misused, and the product's connection with the client's brand/reputation. In short, the conceptual design process could be outlined as follows:

1) market study → 2) design → 3) market feedback

Using the same framework described above, the following structure guides this project:

1) Ethnographic study to obtain contributory design elements, both mechanistic and non-mechanistic. Informants: Group 1 boat designers/builders and Group 2 fishermen. →

2) Design a fishing boat using data from the first step →

3) Determine acceptability of design based upon questionnaire. Respondents: Group 3 fishermen.

The process of design involves a series of decisions not only regarding the details of the final design but also the questions asked and the information gathered to support a design approach. The questions asked and information gathered becomes an important constituent of design, which when coupled with the functional and business requirements support the amorphous design process. The reconciling of conflicting needs affect the quality of the decisions and inquiries made regarding a design. However, the designer is challenged with making design decisions that fall outside the designer's expertise or requires information which is unavailable. These design process voids are described as *bounded rationality*, which recognizes that decisions need to be made based upon partial or fragmentary information.

To alleviate this 'gray' area of design, ethnographic study of stakeholders' perceptions of design are included in my approach. Technical information that includes anthropomorphic data is also integrated into the final design. Ethnographic data helps gain insight into the relationships between fishermen, boat designers/builders and their boats. However, the non-mechanistic forces cannot be studied in their entirety ethnographically. The French philosopher Blaise Pascal wrote in *Pensees*, "The heart has its reasons, which reason does not know" (1670, Section IV). That is, we grasp truth beyond our reasoning ability. We cannot parse the reasons for the allure of a poem or work of art, they stand apart from the world of science. Art exists in design and this aspect of design is difficult to approach in a structured, positivist manner. Therefore a wider net is cast in this study including assessment of aesthetic tradition, commercial design philosophy and iconic imagery. These broad investigations are complemented by a structured measurement of visual stereotypes and the dimensional measurements of one fishing boat hull, which represents a typical newly constructed traditional fishing boat.

This project endeavors to test whether a traditionally educated Western engineer/designer can approach a design task for a specific stakeholder group with different cultural expectations using ethnographic analysis for input into the creative process. This project compels me, as a cultural outsider, to satisfy stakeholders' requirements and develop a concept boat suitable for Class B fishing in Malaysia. Additionally, this project provides a case study suitable for industrial design students.

CHAPTER 2

TERMS OF REFERENCE / OBJECTIVES AND LITERATURE REVIEW

Aims and Objectives

My hypothesis is that I can learn the non-mechanistic design considerations involved in a Malaysian boat design (as an example of product design) and develop my own creative boat design that successfully integrates the identified design factors. Therefore, I manage three processes: 1) acquiring insight primarily with ethnographic methods, 2) creation of a new boat design incorporating these data and analysis, and finally 3) obtaining feedback on the appeal of my conceptual design.

While much of this project is approached anthropologically, achieving the aim of learning and integrating non-mechanistic forces with boat design principles requires multiple methodologies. I use ethnographic methods of interviews and observation as well clay modeling and sketching. This data is coupled with the engineering skills learned through education and professional practice. Additionally, I strive for creative success and I use a creative product analysis matrix to characterize design creativity. I investigated the traditional Malaysian application because I have no connection with this culture and therefore am compelled to rely heavily on my ethnographic data and analysis over my long established technical approaches and cultural perspective.

I provide two tangible products that will benefit professional practitioners. The first is my conceptual design and accompanying questionnaire results that I provide at no charge to Group 1 respondents and the Malaysian Department of Fisheries. The second product is a case study for undergraduate industrial design students. Moreover, this project uses two unique approaches for the design community and can be considered as a possible ‘solution’ to the case study. The first is the use of ethnographic methods for identifying stakeholders’ concerns in a foreign culture and the second is the innovative technique of superimposing images to define traditional shapes as a visual stereotype. Portions of my findings will also be shared with my UTM colleagues.

Design Influences in Boats

Ethnographers and anthropologists have found similarities in boat design features, such as construction techniques and proportion, in disparate parts of the world (Ray 2003). Where similarities are found in boat designs, two schools of thought are connected with their significance. The first is that the same solutions to particular needs were found independently by different societies. That is, they solved the same problems in the same manner without any contemporaneous or historical communications. The other school of thought links design details with contact between societies. The assertion that common design details indicate trade or some sort of communication between societies allows design to be considered as an anthropological tool in suggesting contact between societies (Ray 2003). If design is considered to develop from indigenous knowledge, with some possibility of external influences, then the question is how did the indigenous knowledge develop and is it optimized for the boat requirements?

Mechanistic and Non-mechanistic Influences

The presentation of design influences on boats is best introduced by placing it in the context of what ancient philosophers asserted were the three motivators of all human inquiry: pursuit of truth, beauty and goodness (Liu 2000). This triumvirate of cognition, aesthetics, and morality offers a framework for looking at traditional design as an attempt to 1) develop a boat that will be safe, durable and functional, 2) express cultural heritage and historicity, 3) incorporate belief systems, and 4) express an aesthetic quality. The first category can be referred to as mechanistic influences and the other categories can be referred to as non mechanistic influences.

By design, boats place people far out on the water in an unnatural and hazardous environment. Therefore boats are conservative in their design and often enshrouded by ritual and symbolic elements derived from belief systems. If one is to have faith in a boat when at sea, it seems natural to want to imbue the craft with as much safety as possible, both physical and spiritual. Horridge (1995, p. 151) notes:

> Because the use of them is dangerous, boats are particularly conservative structures and all cultures adhere to their own proven designs. Rigs are more easily copied than hull structures. When changes in design are introduced they are not admitted. In consequence, boat building techniques may survive unchanged for 1000 years or may be quickly modified in a single generation as happens when designs are transferred from elsewhere.

Non-mechanistic Design Influences

Tradition

Tradition derives from a societies need for stability however traditions are dynamic and responsive to creativity (Knudsen 2008). History is often the basis upon which evolving traditions rest (Knudsen 2008, Pick and Dayaram 2006). Traditions can develop quickly if they meet a society's need for a connection with their history as well as possessing some element of attractiveness, such as entertainment, aesthetics, or spiritual appeal (Hugoson 2006, Noszlopy 2005). Traditional knowledge, which can include terms such as indigenous and folk knowledge, is epistemologically grounded in anthropology. Traditional or indigenous knowledge will be reviewed in this study and is defined by the United Nations Environmental Programme (UNEP) as "the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment. This definition encompasses all forms of knowledge – technologies, know-how skills, practice and beliefs – that enable the community to achieve stable livelihoods in their environment."

Indigenous knowledge, the underpinning of traditional boat design, develops in order to provide a practical and beneficial design. However, indigenous knowledge as it applies to design or fishing practices should not be assumed to provide a sustainable relationship between humankind and nature (Kalland 2001). Deforestation, fishing by water poisoning, hunting by large scale forest burns occur even when these actions present some conflict with belief systems. Movement to new fishing grounds may be motivated by a strategy of optimal efficiency that allows them to maximize their catch rather than a conservation value, where transportation time is offset by more effective fishing (Kalland 2001).

Indigenous knowledge is thought to derive from personal experience and an attitude towards the world deriving from populations that have maintained a close interaction with their immediate ecological surroundings as opposed to industrialized populations that are removed from their ecological surroundings and often represent embedded rules that have proven successful (Knudsen 2008). Many subsets of traditional knowledge focus on specific applications, for example traditional ecological knowledge (TEK) emphasizes how groups use natural resources.

Designs are inhibited from evolving for several reasons. These range from collective self-esteem, which is a concept describing an individual's motivation for behavior supporting both a group (as described by group identity theory) and the individual's own self-esteem to resistance to changes of tradition practices (DeCremer 1999). Resistance to change can be rooted in what Horridge (1978, p.41) calls "hidden advantages of traditional designs" such as the diminishment of concentrated frame loads by connecting planks to one another with trunnels (wooden dowels). This technique produces a monocoque construction and reduces the loading where the rib contacts the hull. Monocoque construction uses the external 'skin' of a boat for structural support rather than an internal framework. This monocoque construction is an ancient Indo-European tradition (Horridge 1978) and is still used in Malaysia, particularly in Kuala Terengganu.

Mapping

Mapping describes the relationship between visual cues and function, such as scissor handle holes sized to handle either the finger or thumb. The mapping of a product or system is an important industrial design concept. In products and systems that are vital to safety, it is critical to make the mapping as clear as possible. Deviating from this approach requires thorough training of the user. Consequently, traditional mapping needs to be taken into account so that a new design is approachable by those who have experience with an old design. That is, the critical features of the concept boat, such as at the helm, should be mapped similarly as in the past to avoid confusing fishermen.

Cultural Heritage

The relationship between the individual, society and history is considered in the concept of cultural heritage. Cultural heritage recognizes that individuals and groups attribute powerful significance to their history and strive to preserve it. Forces that change an identified cultural heritage may be resisted as the dissonance between identified cultural heritage and contemporary actions is reduced (Loulanski 2006). This resistance can also be understood by considering the power of group identity, described in further detail later, in preserving the vital definition of a group upon which the individual derives identity. While traditional knowledge can be thought of taking the past and applying it to the future, cultural heritage motivates people to look at the present and relate it to the past, much like ethnography can inform anthropology and anatomy can guide paleontology.

Material Culture

Indigenous knowledge is not merely applied to problem solving, such as letting a boat do a certain task. The knowledge reflects material culture, which attributes cultural identity to material things. That is, people understand material objects as they have been learned from their culture and to identify boat design influences one is compelled to understand the relationship between material objects and meaning. Boat design considerations could derive from a sort of filial piety where one identifies with one's ancestors by incorporating elements they value into design (Chou 2003, Leach 1989).

Material culture is a cohesive force for group identity in the Malay world, Chou (2003) notes:

> A direct relationship between material things and group identities [exists] among the Orang Laut and Malays. Both groups classify artifacts and skills into categories to reinforce their material expression and intersubjective order for patterns of interaction with the Malay World. These artifacts and skills have become positional markers for members in the Malay World to signify their relatedness or difference. As such, the choice or avoidance of such things and skill is interpreted as conveying affiliation or non-affiliation with a sub-culture (p. 3).

Group Identity

Because group identity is connected with design considerations as they derive from 'tradition', exploration of group identity becomes important to the understanding of these design issues. Sociological identity theories describing the relationship between an individual and a group are built upon the specific denotation of *self*. The notion of self is used frequently in describing the relationship of an individual to a group. Self is defined as all the values that characterize 'I' or 'me'; it includes the awareness of 'what I am' and 'what I can do.' Individuals' sense of self is formed by the process in which they "categorize, classify, or name [themselves] in particular ways in relation to other social categories or classifications" (Stets 2000, p. 2). Identity theory asserts that one's self esteem is derived from the identity developed from social interactions. The sense of self is based on the roles that one assumes in a society or group which one identifies with (Stets 2000). The *social identity theory* places an emphasis on the large-scale social grouping of individuals: group members need to protect the positive image of their group to satisfy the self-esteem they derived from the group, they regard other groups as inferior to their group (Hogg 1995).

Experiments, ranging from the 1964 work of Ferguson and Kelley's to DeCremer's in 2000, lend credence to the notion that group members will act in ways that protect their group. The Ferguson and Kelley experiment found that group members tended to support their own group regardless of facts. DeCremer's study related this tendency to an individual's quantified affiliation to a group. DeCremer's research found that group members with strong group identification attributed successful endeavors to the group members and negative group outcomes to external factors. Those who identify weakly with a group were more inclined to attribute negative group outcomes to group members and positive group outcomes to external factors.

Researchers have tried to differentiate self-esteem derived from deep personal motivation to that derived from a group. The term *collective self-esteem* was developed as a measure of an individual's motivation for behavior that supports both a group and one's own self-esteem. DeCremer used a survey developed by Luhtanen and Croker to quantify the collective self-esteem of individuals within a test group (DeCremer 1999). DeCremer found that people measured with a high collective self-esteem level tend to be more protective of their group than those with a lower collective self-esteem. Myths within a group or organization can also perpetuate a group identity. They can "reaffirm the organization's picture of itself, its own theory of how to get things done and how to handle interrelationships" (Schein 1988, p. 81).

Therefore, a community may design and construct boats in a manner that maintains their group identity. This can be the origin for non-mechanistic design elements. Changing a design feature could insult tradition, or more specifically, it could be an affront to the group identity. Consequently, design elements derived from 'tradition', in the sense of group identity, fall in line with aesthetics as being non-mechanistic.

Malaysia is a multiethnic nation, comprised of three large ethnic groups: Malay, Chinese, and Indians. The political parties are rooted in ethnic identity. The Malays are the largest and politically dominant group while the Chinese are traditionally the most economically prosperous. The Chinese (mainly from southern China) were brought into Malaya to work the tin mines, while the Indians (principally Tamils) immigrated to work the rubber plantations. The southern Chinese dialects are still spoken among the Chinese, along with the more universal Mandarin. Tamil is spoken among the Indian Malaysians. The Indians are not connected with the fishing industry while both the Malay and Chinese are involved.

Many recent historical issues mingle into the ethnic politics. The Chinese were most active in resisting the Japanese during World War II and they bore the brunt of Japanese atrocities. The resistance movement morphed into an anti-British Chinese communist insurgency that did not cease until the 1970s. The separation of Singapore in 1965 was also related in part to ethnic politics because it reduced the Chinese population below the Malay population assuring Malay political dominance.

Aesthetics

Aesthetics is defined as 'pleasing in appearance' and, while an important design consideration, this quality is subjective and defies quantification. Aesthetic assessment can be informed by all the sensory inputs: sight, sound, touch, smell and taste. The interplays between these senses are complicated, for example, the visual appearance of a perfume bottle is often as important as the smell while the thickness, shape, crunch (biting pressure) and color of a potato chip influence the consumer experience beyond smell and taste (Liu 2000).

The foundation under which aesthetics are evaluated is a contested issue among philosophers. The philosophical school of aestheticism believes that aesthetic evaluation is independent of other judgments while the instrumentalists believe that aesthetic value is connected with their functionality (Liu 2000) However, in boat design, form and function are intertwined and one would never find an applied boat design that was not reasonably hydrodynamically efficient.

Mechanistic Design Influences

Whereas indigenous boat design knowledge can derive from traditional influences that lie outside the realm of naval architecture, the knowledge applied to design makes the best use of available construction materials, fastener experience, and specific application. This knowledge also leads to design details that affect performance and safety. When asked to explain specifics about a design, traditional builders may respond in a generic fashion, indicating there is no other way to design the boat or the design gives better performance (McGrail 2003). Construction details have been relayed from their ancestors and deviations from this tradition are considered dangerous (Horridge 1995).

The details of the boat are ostensibly designed in response to a particular need. For example, the sharp bow allows a boat to pierce waves, a shallow draft allows passage over sandbars and an open transom allows nets to be easily pulled onboard. The overall boat design is dictated by needs for stability, buoyancy, maneuverability, seakindliness, draft restrictions, superstructure and equipment requirements. However, in addition to these mechanistic elements, boat designs also derive from traditional designs, traditional construction methods and available materials. In addition to these traditional influences, boat design is influenced by perceptions regarding durability, safety, comfort, and maintenance.

The intent of these descriptions is to provide a framework for the technical aspect of boat design. This overview of boat features underscores the multiple parameters involved with boat design, which even taken from a purely mechanistic approach, requires the designer to make judgments about the most common type of application a boat might encounter. Based on these judgments, the designer can proceed fully recognizing the many conflicting design issues such as performance versus aesthetics, stability versus capacity, comfort versus seakeeping, safety versus speed, safety versus ease of use, hull size versus operating cost, and fuel efficiency versus production cost. The following sections describe key mechanistic factors.

Stability

Stability is defined as the property of a body to develop forces that restore the original condition when disturbed from a condition of equilibrium or steady motion. The stability of boats must be ensured in high seas states as well as under varying boat loads. Stability increases with a low center of gravity and a wide beam increases a boat's initial stability. However, adding weight to lower the center of gravity and increasing beam reduce a boat's speed. Consequently, the stabilizing forces needed in high seas states have to be measured against boat performance.

The point that the buoyant force acts is called the center of buoyancy, which is located at the center of gravity of the displaced water. To produce a stable object, the center of gravity of the object must lie in vertical alignment with the displaced liquid's center of buoyancy. Boat stability is defined by the buoyant forces produced by the hull shape that maintain the boat's trim when the center of gravity and buoyancy move out of vertical alignment. When wave action and other dynamic forces rotate the hull, the shape of the displaced liquid changes and therefore moves the center of buoyancy. For small angles of heeling, the center of buoyancy rotates around the metacenter. Initial stability increases with increased distance between the metacenter and the center of gravity. The horizontal distance between the center of buoyancy and the center of gravity determines the righting moment (moment is the product of force and the distance over which it acts).

A square, broad section has more initial stability than a round section because, when rotated, the sinking edge of the square hull increases the restorative buoyant force. The further the edge is driven under, the stronger the buoyant force. Additionally, a wide beam produces a stronger righting moment than a slender beam. A round hull section behaves much like a cylinder. A cylinder has neutral stability and does not produce a force that will rotate it back to a given position; this is seen with floating logs that will readily rotate.

When a moment is applied anywhere on the boat, it will roll around the center of floatation. The center of floatation is the center of the waterline area. With a rectangular waterline section, the center of floatation would be in the middle, whereas with a section in which the stern was much wider than the bow, the center of floatation would be located closer to the stern.

Hull Resistance

Hull resistance is dependent on hull length, hull speed and water properties (specifically viscosity, density, bulk modulus, vapor pressure and surface tension). The resistance of a hull to flow includes the viscous, wave-making, form, and eddy effects. However, when considering low speed applications (and ignoring surface tension forces, cavitation, and air resistance) the dominant resistance terms are associated with viscous and wavemaking resistance (Taylor and Tang 2006). This functional relationship can be simplified to:

$$R = \rho V^2 L^2 \left[f_1\left(\frac{\upsilon}{VL}\right) + f_2\left(\frac{gL}{V^2}\right) \right] \qquad \text{(Formula 2.1, Taylor and Tang 2006, p.119)}$$

Where,

ν = kinematic viscosity
ρ = density
V = hull velocity
L = hull waterline length
g = gravitational acceleration

The viscous forces acting on a hull are affected by water viscosity, velocity and wetted surface area, as indicated in the first function. Wavemaking resistance is a measure of energy required to move water out the way of the hull; therefore, the second function includes the gravity term. Wavemaking resistance is affected by the Froude Number and the hull geometry, particularly beam to length ratio and displacement. Figure 2.1 illustrates the viscous and wavemaking resistances as a function of hull velocity.

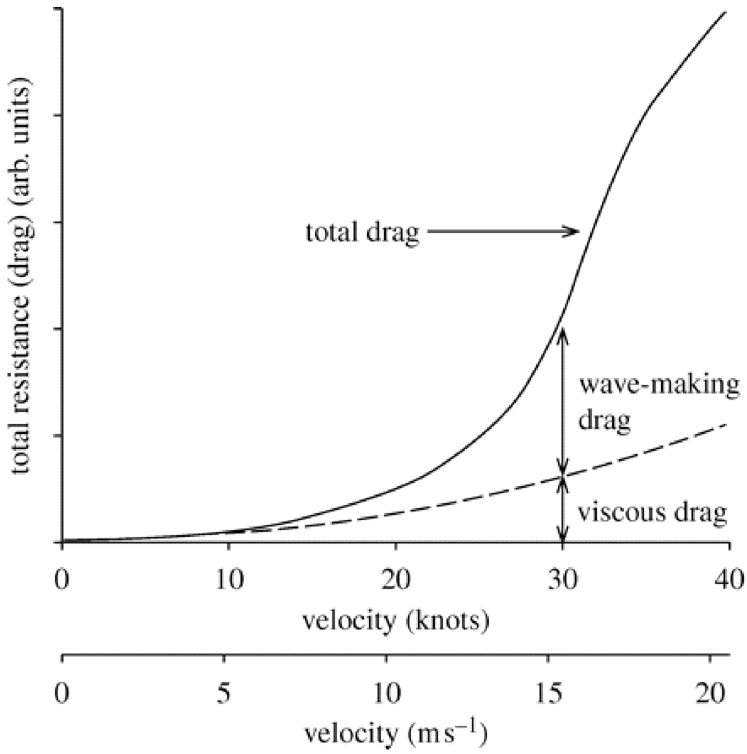

Figure 2.1 Components of Hull Resistance (Salta et al. 2010, p. 4732)

When considering hull performance in waves, three factors become important in evaluating hull behavior. These factors are length to beam ratio (L/B), distance between the longitudinal centers of buoyancy and floatation, and finally the radius of gyration. McGrail (2003) can be referenced as an example of hydrodynamic assessments of traditional South Asian boats based some of these parameters. Additional information on hull behavior and calculations of other naval architectural parameters can be obtained by modeling hulls with commercially available software applications such as MaxSurf; however, this modeling is beyond the scope of this study.

Hull Shapes

Hulls are most often described by their shape. The four common hull designations are displacement, semi-displacement, and planning described as follows:

Displacement Hull

A displacement hull forces water past its bow and sides as it is propelled through the water. The maximum speed of a displacement hull is constrained by its length. As the hull is forced through the water, a bow wave is produced. When the speed of the boat is such that the peak of the wave is in sync with the trough produced at the stern the hull cannot go faster regardless of additional power. If the hull is driven harder, the stern squat increases and constrains the forward speed.

Displacement hulls provide a large amount of interior space relative to other hull shapes. They are relatively stable, seaworthy, and have good economy of operation because they use relatively small engines with low fuel consumption rates.

Semi-Displacement

Semi-Displacement hulls are an important design as they are commonly used on large boats requiring greater speed. Semi-displacement hulls typically employ straighter bottoms, wider transoms, lighter displacement and more power than displacement hulls. The flatter underbody allows the boat to rise above the bow wave. They are more seakindly than planing hulls yet not as seaworthy as displacement hulls. Given suitable power, a semi-displacement hull can be driven nearly twice as fast as a displacement hull.

Planing

Planing hulls are designed with a flat bottom to provide hydrodynamic lift to the hull when in motion. Flowing water pushes the flat surfaces up out of the water to decrease the wetted surface area and reduce the effect of wave making from the hull and the stern squatting.

Block and Prismatic Coefficients

The shape of a hull can be characterized by two coefficients, block and prismatic. The block coefficient indicates the shape of the cross section; a high block coefficient indicates the hull shape is more rectangular than a hull with a low block coefficient. A large prismatic coefficient indicates a full bow and stern, while a low prismatic coefficient indicates slender ends of the hull.

Froude Number and Speed to Length Ratio

The Froude Number (Fr) and the Speed to Length Ratio (S/L) are descriptors of the relationship between the size of the bow wave and the length of the hull. These values are used to relate hull shape to maximum hull speed. Both the Froude Number and Speed to Length Ratio are functions of boat velocity divided by length of the boat at the waterline. A symmetrical hull shape will produce the speed-limiting squatting phenomenon at an S/L ratio of 1.4. A fine bow and flat stern increases the maximum S/L ratio as it becomes more of a semi-displacement hull. The flatter stern resists squatting. A broad bow and stern will decrease the S/L ratio. Different hull shapes have different maximum S/L ratios. Displacement hulls typically fall within 0.80 - 1.4, semi-displacement range from 1.4 - 2.5 and planning hulls S/L ratios are over 2.5

Drag

Drag is produced by a hull’s skin friction, poor streamlining and wave-making. As speed increases, all of these drag forms increase for most hulls. Friction drag can only be reduced by smoothing out the boat's wetted surface and reducing the total wetted surface area. Streamlining reduces pressure drag. Pressure drag is the difference in pressure between the bow and stern. Flat surfaces facing the flow of a fluid produce high pressure while flat surfaces at the back produces low pressure. Another form of drag is wave-making, which is the vertical lifting of water as can be seen at the bow wave. This wave-making drag contrasts with the pressure drag that is associated with moving water horizontally around the hull

Hull Refinement

For a given length, hulls will have widely varying beams, drafts and displacements. The length of bow and stern overhangs along with deadrise angles and sheer lines give unique character to a hull.

Beam

Displacement hulls length is dictated by the required load carrying ability. However, determining the beam involves balancing different consideration. Wide beams increase the wave-making characteristic of the hull as well as the wetted surface. Increased wetted surface increases drag. However, beam does provide considerably to the boat's initial stability so balancing drag and stability is dependent on the seaworthiness requirements and application.

Unfortunately, excess stability produced by the beam generates a harshly rolling ride, especially in beam seas. However, the rolling characteristics of the hull are not strictly dependent on the beam. The cross sectional shape of the hull is another key factor affecting seakindliness; flat deadrise, U-shaped sections give harsher motion than rounded sections.

Displacement and Deadrise

A low center of gravity is another method of achieving stability without increasing beam. A narrow beam generally gives a more comfortable ride. However, if the beam is very narrow it will respond too quickly to wind gust and shifting crew weight. The most seakindly hulls will have the stability gradually increase as one end is driven down by wave action or wind force. That is, the hull will not instantly respond to every wave-induced roll.

Overhangs

The overhang of the bow and stern will affect how the hull will respond to waves. The overhang's function is to offer reserve buoyancy that prevents the hull from plowing into waves due to the inertia of the boat. As the bow is driven into a wave, the bow buoyancy increases quickly and the bow lifts out of the wave. The same is true at the stern. A full bow and stern as indicated by a high prismatic coefficient, has a similar effect. The advantage of overhang compared to full beamed bows and sterns is that overhangs do not contribute to drag when not immersed in water and they provide a longer moment arm to the center of floatation and therefore require less buoyancy for a given corrective moment. The overhangs of small craft are also accompanied by a sheer line that rises up at the bow to increase the freeboard at the bow. This balances the finer beam at the bow with additional reserve buoyancy developed by the higher freeboard. The shape of the overhang under the waterline is also important. A curved forefoot (rounded profile under the stem) will tend to slam into waves and therefore have lower efficiency. Because the overhangs do the work of maintaining trim in high sea states, they can be subject to heavy loads.

Bow and stern overhang must be moderated to an extent. Too much overhang will give a harsh motion as the hull and stern pitch the boat in prompt response to the waves. This degradation in seakindliness is the same behavior that occurs athwartship when excess stability from the section shape causes the boat to roll quickly. With excess overhang, the bow and stern will lift too quickly in response to wave action. Therefore the amount of overhang needs to be reduced to a point that it produces a safe, dry and smooth ride. In addition, as the boat weight is decreased, the inertia is decreased and therefore the overhang requirement declines. However, when speed is the only consideration, overhangs reduce speed. The overhangs do not contribute to the waterline length (which dictates maximum displacement hull speed) but add weight.

Canoe shaped sterns will allow for more maneuverability in following seas than a flat transom. When wide, flat transoms are hit by following seas, they can cause the boat to yaw uncontrollably. However, the narrow canoe will tend to squat in the water when under power but will allow smooth inflow of water to propellers.

Structure

Most boats are made with a skin attached to a framework consisting of longitudinal stringers and athwartship bulkheads or web frames. Two construction approaches are generally employed for wooden boat construction: shell built and skeleton built. Shell built construction describes the process where planking is first fastened together than frames inserted into the resulting shell. Skeleton built construction is the opposite of shell built, where frames are first formed and the planking laid on them.

Longitudinals (often referred to as stringers on small boats), give longitudinal strength, preventing the hull from flexing up and down along its keel. Transverse bulkheads and frames resist hull twisting. Both the longitudinal and transverse structures are integrated to provide a strong hull. The transverses, such as bulkheads, support the longitudinals and the longitudinals support the transverses. Bulkheads are used not only for stiffness but also for reserve watertightness.

Traditional Design and Building Technologies

Two principal motivators for design change are increasing boat size and the design influences arriving with Western contact. Horridge (1978) assert that the origin of boats in the Malay world derives from built up dugout canoes and this relationship can be seen in some traditional craft in the Indian Ocean and Pacific. This inference arrives because the keel is carved and hollowed out like a dugout canoe and then planks are attached with trunnels (Horridge 1978). However, the traditional Malaysian fishing boats in this study have straight keel bars and no connection with dugout canoes can be discerned. Horridge (1978) used linguistic analysis of the Malay word for keel to infer a Portuguese derivation. Another possible design change due to Western contact are that fishing boats have squared sterns which, except for Chinese junks, were not found in the Indian Ocean area until 1500s and the arrival of Westerners (Horridge 1978).

Boats of the Malay world have been connected to Western traditions in several ways. The use of trunnels to connect planks as is done in the Kuala Terengganu tradition is an ancient Indo-European tradition deriving from internally lashed lugs and sewn boats (Horridge 1978, Casson 1991). This construction technique provides a monocoque shell while providing flexibility and resistance to bending and twisting. Monocoque construction with trunnels is also thought to avoid the problem of stress concentrations such as occurs where a rib contacts a hull. In the case of doweled plank connections, a failure in one trunnel will cause other trunnels to fail resulting in a diminishment in localized loading. The dowel construction has parallels in ancient Egyptians and in the West; however, Horridge (1978) asserts they were developed in the Indian Ocean area prior to the arrival of Westerners. Horridge (1978, p. 41) uses this design detail as an example illustrating that "these hidden advantages of traditional designs are strong factors in the resistance to change."

Overview of Traditional Malaysian Boat Construction Techniques

Traditional Malaysian boats are normally built without drawings although design templates have been known to be maintained (Zamani 2000). The planks are bent either by the simple application of force using clamps or by heating them with fire. The planks are fastened to the frames, usually by galvanized hardware. On the east coast the planks are joined to each other using small trunnels typically made from iron wood (*mesua ferrea*). This plank joining technique is also coupled with a traditional method of sealing the planks in which a 1-2 mm thick layer of *melaleuca* tree bark is pushed over the trunnels. Adjoining planks are hammered over these trunnels. In contrast to this traditional technique, plank sealing is produced on the west coast and some areas of the east coast, by pressing rope (which was traditionally jute) between the planks. I sometimes saw this rope impregnated with sealant.

Previous Studies of Traditional Malaysian Fishing Boats

Omar and Chau (2005) have characterized fishing gear and crew size as well as fish catches versus wind and wave conditions. Their study found that traditional fishing boats employ, in order of gear group popularity, either drift/gill nets, trawl nets, hook and line, or purse seine nets. The purse seine technique requires much bigger crews than other techniques. For boats with a volume of 39.9 to 69.9 GRT, a purse seiner uses an average of 19.60 crew while trawlers require only 5.05. Between 9.9 and 39.9 GRT, a similar ratio exists. Purse seiners of this size require an average crew size of 14.81 and a trawler 3.67.

Traditional Malaysian fishing boat design has been studied by Zamani, Chua, and Zawahid. In addition, Horridge produced a monograph based on an extensive anthropological study of boats in the Moluccas. Zawahid's study most closely matched this study in his development of a FRP (fiber reinforced plastic) design suitable for Malaysian fishermen.

Zamani (1999, 2000) incorporated Chua's (1998) study of 16 vessels (13 trawlers and 3 purse seiners) along with his own observations and measurements to assemble data that provides two categories of findings. First, are the comparison of typical naval architecture design parameters that describe the hull form and affect the performance of the hull (Table 2.1) and the second are idiosyncratic features that appear to be unique to Malaysia and provide a basis for geographic grouping of designs.

Table 2.1. Trawler data for prismatic coefficient (Cp), length to beam ratio (L/B), beam to draft ratio (B/T) and length to displacement ratio ($L/\nabla^{1/3}$) Zamani (2000).

	Cp	**L/B**	**B/T**	**$L/\nabla^{1/3}$**
Hotrop (1984)	0.55-0.65	3.90-6.30	2.10-3.00	
Pattulo (1963)	0.63-0.65	4.60-5.80	2.00-3.50	4.40-5.10
Calisal (1993)	0.65-0.70	2.60-4.00	2.00-3.00	3.00-4.70
Malaysia	0.62-0.78	2.70-3.01	2.47-3.77	3.26-4.42

Zamani found that the differences between scientifically derived designs and traditional Malaysian designs were that the Malaysian trawlers had comparatively low length/displacement ratios, low beam/draft ratios and high beam/draft ratios.

Zamani's studies relate to hull resistance and efficiency, suggesting that changes to the hull design below the waterline could improve hull performance. However, these studies do not look at features above the waterline that can affect overall performance such as overhangs and sheer lines.

Design Idiosyncrasies

In addition to hull form issues, Zamani (2000) identified various features of Malaysian trawlers that were distinctive. These include:

- Bilge keels are often found in trawlers of the northeast peninsular Malaysia, consisting of Kuala Terengganu and Tumpat. Zamani speculated that this is due to the rougher conditions of the South China Sea. The trawlers in this region tend to have a V shaped hull rather than a flat bottom as they do in other regions.
- A second, stepped transom is found in the trawlers of northwest peninsular Malaysia, consisting of Penang, Pangkor Island, Teluk Intan and Kuala Kedah. Zamani speculated that this would allow for higher loading of fish as the second transom (overhung) becomes immersed in water.
- The keel of the east coast Teluk Intan trawlers kinked in the center with a four degree angle downward from the center. Zamani asserts that this allows for the installation of a larger propeller.

- Some trawlers have an ‘omega’ shaped hull cross section at the stern.
- Some trawlers have angled bilge keels that do not lie parallel to the keel bar.

Zahwahid’s (2003) study considered the performance of FRP in detail and compared the materials performance with wood, aluminum, steel and ferrocement. Zahwahid investigated means to provide more working deck space and developed a conceptual boat of 13.1 M with a deck forward design that is modified from a similar Icelandic boat. This design also specified engine and drive details as well as improvements in fish holds. Tank testing of trawling hulls has also been conducted at UTM.

Although Horridge’s (1978) monograph did not focus on Malaysian fishing boats, his study is important because he considers construction details in piecing together the historical lineage of boat designs in the Moluccas, the Indonesian islands between Sulawesi and New Guinea. He investigates methods of plank attachments and details on the closure of the stem and stern and uses this data to suggest boat design connections throughout the Pacific. Horridge also identifies stem and stern details of planked boats and compares them with a typical Western design.

CHAPTER 3

METHODOLOGY

Introduction

Since successful design often requires an insightful blend of technology, marketing, cultural understanding and aesthetic sensitivity, this project's methodology uses a transdisciplinary, multi-pronged approach in order to explore each facet. The principal method is ethnographic, using interviews, observations, and questionnaires. This method is coupled with data connected to visual stereotypes, anthropometry, creativity appraisals, aesthetic traditions, iconic designs, and commercial design philosophy. I also measure a traditional Class B fishing boat to develop a lines drawing of the hull. This study also incorporates anthropomorphic data into the helm design and judges the creativity of my designs using an appraisal rubric. A questionnaire is employed to obtain feedback from fishermen on my design concepts to provide feedback on the suitability of my design concept.

Overview

For the purposes of this project, Class B fishing boats of approximately 15 meters length were investigated. Overall, the project relied upon three informant populations (details included in Appendices 4 and 5):

- Group 1: Six designers/builders of traditional fishing boats and four boat repairers, one of whom had previously built boats.
- Group 2: 41 fishermen who use traditional fishing boats. 15 additional informants were interviewed who were affiliated with fishing or boatbuilding, such as fish brokers and Malaysia's Department of Fisheries personnel.

- Group 3: Twelve fishermen who use traditional fishing boats (unaffiliated with Group 2). This group completed a questionnaire to provide feedback on the conceptual boat design.

After obtaining data from Groups 1 and 2, the resulting information guided the conceptual design which, in turn, was presented to Group 3. The latter was asked to rate the attractiveness of the design, through a questionnaire that related the concept design against a traditional Malaysian boat of similar function and a contemporary Western style, deck forward design. Group 3 was developed to ensure that my interactions with Group 2 did not influence the results because the Group 2 fishermen were asked questions and cooperated in observations that may have produced some ownership of the conceptual design. In contrast, Group 3 represented fishermen with whom I had no prior connection and my only interaction was the administration of the questionnaire.

This project has two phases:

Phase I	Learn and document small boat design methodology and factors that influence design. Observe and interview boat designers/builders, owners and fishermen. Measure a newly built traditional fishing boat.
Phase II	Design a boat, assess it with the CPAM rubric, and characterize their suitability and attractiveness to fishermen.

Understanding traditional Malaysian design methodology

Semi-structured interviews and observations were used to survey Group 1 (boat designer/builder) and Group 2 (fishermen), while feedback on the conceptual design (i.e. how well the ethnographic study was integrated in the creative design work) was collected from Group 3 (fishermen) via questionnaire.

The structure of the ethnographic study is as follows:

1) Interview and observe boat designers/builders (Group 1 informant). This information is used to generate questions and culturally relevant topics, questions and issues to study.
2) Use observation and semi-structured interviews with Group 2 informants. This data is used to support a thematic analysis and identify mechanistic and non-mechanistic concerns that will be applied to my concept design.
3) Administer a questionnaire of Group 3 (fishermen) to evaluate their interpretation of my concept design. Additionally, the design was also self appraised using the Creative Product Analysis Matrix (CPAM) and related to the identified visual stereotype.

A flowchart of the project is presented as follows:

Project Flowchart

Phase I

1. Literature review

$\Downarrow$

2. Observation, develop and administer semi-structured interview, Group 1

$\Downarrow$

3. Develop Group 2 written semi-structured interview schedule

$\Downarrow$

4. Observation, administer semi-structured interview, Group 2 (includes sketches and clay models)

5. Photograph traditional boats to define prototypical elements of visual stereotypes (concurrent with Steps 2 and 4)

$\Downarrow$

Phase II

6. Identify design elements, mechanistic vs. non-mechanistic (triangulate with literature review (Step 1), interviews/observation (Steps 2 and 4), and photography (Step 5)

$\Downarrow$

7. Create conceptual design with sketches and clay models

$\Downarrow$

8. CPAM

$\Downarrow$

9. Group 3 questionnaire

Methodologies

My engineering education is rooted in the quantitative paradigm; however design, particularly within a different culture, compelled me to look broader at research frameworks. Understanding non-mechanistic elements of design required understanding rooted more in cultural anthropology than engineering and a constructivist framework.

The framework for this project is in the constructivist tradition with a relativistic ontology recognizing multiple realities and a subjectivist, interpretive epistemology. This epistemology supports the premise that knowledge arrived at does not represent some absolute truth but rather recognizes that knowledge is created by the interaction of me and the informants. The methodology is ethnographic to which is coupled positivistic approaches of visual stereotype identification, a creativity measuring rubric, anthropometry and naval architecture/engineering.

The epistemologies rooted in phenomenology and grounded theory are two commonly blended methods. These theories recognize that participants' experiences are formed in the context of their cultural and social experiences. Moreover, they both “focus on the richness of human experience, seek to understand a situation from the subject’s own frame of reference, and use flexible data collection procedures” (Baker, Wuest, and Stern 1992, p. 1355). However these methods have different purposes. Phenomenology has Husserl’s philosophical roots and strives to parse essential truths, while grounded theory has Glaser and Strauss’ sociological roots of symbolic interactionism, where humans are “both products and producers of symbols” (Madison 2005 p. 64) and employs socially derived meaning from data.

Framing research with mixed methods that help bridge the ‘paradigm wars’ (comprised of distinct ontology, epistemology and methods paradigms) between qualitative and quantitative methods have been used previously (Tashakkori and Teddlie 1998). The mixed methods employed in this project are a unique approach to design engineering, primarily because the interpretive epistemology and naturalistic methods are uncommon in mathematical approaches to design. Where the designer might rely on published standards for strength, stability and specifications, applying interpretive methods seeks the culturally appropriate answers to: what is strong enough, what is stable enough, and what do the stakeholders really want? This project does employ unique methods such as in developing the visual stereotype, assessing creativity with a rubric and using clay modeling as an adjunct to interviews.

I used mixed research methods to obtain data on design influences but my epistemology primarily falls in the interpretivist tradition and reliance upon qualitative research. I recognize that my experience lies within a unique interpretive community and because I am the instrument of my epistemology I attempt to improve validity by offering a statement of my positionality later in this Chapter. The fishing industry pursues quantifiable measures, namely fish and profit. Other lifestyle and safety issues arise in their practice but quantifiable measures, such as fish landings, fuel consumption, labor costs and fish prices dominate their thoughts. This tradition of quantification also dominates the engineering and design professions.

Whereas scoping design parameters of a project falls in the realm of marketing for consumer products that then guides designers in custom products, employing the social sciences, particularly anthropological approaches, at the onset of a design is unique to this project. This transdisciplinary approach is intended to mitigate the commonly overpowering design influences of mechanistic efficiency and economics in engineering-driven projects and the rejection of 'sound' design by the recipients.

Mixing qualitative methods can be contentious, some researchers think this weakens the rigor of research (Baker, Wuest, and Stern 1992; Wilson and Hutchinson 1991) while others argue for mixing methods in a logical format helps address specific issues (Tashakkori and Teddlie 1998, Bernard 2006, Denzin and Lincoln 2000). The mixed methods employed in this study are particularly effective in the pursuit of culturally appropriate design.   Blending qualitative methodology allows be me to go beyond the quantitative and incorporate cultural factors into a resulting products that represents the best of engineering and cultural values.

Ethnography

While my personal aspiration is to improve the design of fishing boats, it is presumptuous to think that one can fully identify the cultural, economic, and technical issues with which Malaysian fishermen contend. In the context of designing in an environment much different than my personal experience, the positivist approach which typifies engineering needed to accept the descriptive data of ethnographic study.

In this respect, it is clear that ethnography does not test a hypothesis as much as it explores cultural elements. However, the challenge in broad based data acquisition as employed in ethnographic studies is to avoid domination of one component over another, such as material dimensions over historical context, history over culture, the unnoticed over the publicly observable (Bharadwaj 2007). Another challenge to ethnographic studies is ascertaining the validity, an issue that will be described later in this Chapter.

Ethnography in Design

An ethnographic study of design draws upon the humanist arguments such as Protagoras' (485-410 BC) assertion that "man is the measure of all things," and Husserl's appreciation of the limitations of the scientific method and its inappropriateness for assessing human thought and actions.

Ethnographic techniques allow me to delve into the technical and human influences on boat design. The descriptive nature of ethnography requires a trained subjectivity, where I acknowledge my biases as I distill the data and apply it to the conceptual design. These cultural design concerns will be incorporated into my design; as such my study needs to identify them accurately and then attempt to analyze their origin and implication. By understanding the underlying culturally specific motivators of design I can break from tradition and move to culturally enhanced design innovation.

Bounded Rationality

Bounded rationality is a concept that is helpful in characterizing this particular design process. This concept asserts that decisions need to be made with partial, sometimes fragmentary, information, where feedback is achieved only in the future (Module Guide 2007). Therefore, value has to be attributed to the decisions immediately. This theory further recognizes that not all alternatives are considered before a decision is proffered. Heidegger's form of the dialectic in which one continually re-asks the same question is consistent with the argument that to contend with the concept of bounded rationality one must "replace the optimum by the sufficient" (Module Guide 2007, p. 111).

Bounded rationality relates to the process of design based upon ethnographic study in so far as the ethnographer/designer will never completely understand the target market but will gain helpful insights using ethnographic tools. Moreover, the creative design process requires rapid distillation of numerous ideas and this process can discard or fail to consider good design concepts; most notably, a designer is required to use good judgment and be confident in results. For most businesses, it is impractical to develop a thousand design ideas, convene a thousand focus groups and proceed with the 'best' design that derives from this expensive and time consuming process. Rather, the designer is encumbered by the fact that the target user does not necessarily know what he or she specifically wants, even though they are usually sure as to what they do not want. In this respect, design is not fully rational and the notion of bounded rationality provides a good construct for understanding how ambiguity is tolerated in the design process.

Data Collection

Selection of Informants

With the exception of the boat designers/builders, no specific referrals were identified prior to the fieldwork. Contacts at the Marine Technology Department within the Faculty of Mechanical Engineering at UTM who were familiar with all the boat building centers for traditional fishing boats provided guidance on the best communities to visit. The boat designers/builders in these communities comprised the Group 1 boat designer/builder population. In order to study them, nearly all locations were visited, excepting Teluk Intan, a Chinese boat building enclave in northwestern peninsular Malaysia. Additionally, UTM colleagues were helpful in introducing me to Department of Fisheries personnel who were then able to organize my accompaniment of two fishing crews.

Group 2 fishermen were found by spending time on coastal fishing docks. Locations with large fishing communities that normally cluster around the natural harbors provided by estuaries were chosen. The varied locations and ethnicity (Malay and Chinese) provided data triangulation. Each location was accessible by road, with the exception of Pulau Ketam, which was accessible only by boat. The northwestern peninsular coast was the notable exceptions to my sampling, which was omitted due to time constraints. Instead most research efforts were concentrated on the east coast, an area that encounters higher sea states, and is worked by both Malay and Chinese fishermen. However, the east coast boat designers/builders are primarily Malay. While Sarawak in East Malaysia on the island of Borneo was surveyed, the traditional fishing boats encountered were made in Indonesia. However, I did find interesting design connections on river boats.

In order to verify potential participants, specific questions were asked, such as, “what kind of fishing do you do?” and “how long have you been a fishermen?” The authenticity of these claims was further reinforced by the fact that the interviews were held at the docks or, in one case, at a canteen next to the dock.

Group 3 fishermen were found nearly in the same way except I limited my geographic region to southeast peninsular Malaysia. For these interviews, I traveled to Mersing and elicited the help of Department of Fisheries personnel in administering the questionnaires (available in either Bahasa Melayu or Mandarin). I also traveled with the

Department of Fisheries personnel to Endau where they conducted questionnaires in their offices.

While the presence of Department of Fisheries personnel would have been disruptive for the more open interviews of my Phase I study, the Phase II investigation supported by the Group 3 respondents was highly prescribed. These data were obtained with a translated questionnaire and outline drawings of the boats on the bottom of each page. Scaled, clay models also accompanied the questionnaire. However, because in most cases the Department of Fisheries personnel read the questionnaire to the respondents (with me in attendance), a potential for biases exist in the data.

In the course of my fieldwork I also interviewed boat owners (who were not fishermen), retired fishermen, boar repairers, fish brokers, FRP boat builders, and steel and aluminum ship builders. Although not a formal part of my research plan they added background information that was helpful in my study. Like the fishermen, these informants were found randomly while exploring the fishing communities.

Interviews and Observations

Literature has indicated that blended methods are a common and effective approach for data acquisition (Bell 1999, Sommer 1991, Ellen 1984, Yin 1989, Bernard 2006). The mixing of techniques is so common, in fact, that Bernard (2006) notes that observation actually includes interviewing under its domain; furthermore, that observation has an array of techniques which support it, including "observation, natural conversation and interviews (structured, semi-structured, and unstructured), checklists, questionnaires, and unobtrusive methods" (p. 384). Interviewers must recognize that asking a question often compels the respondent to reflect upon a design feature or experience so that even with naturalist studies, the research affects the setting.

Bernard (2006) describes fieldwork as involving three different roles: complete participant, participant observer, and complete observer. The first requires one's research to be unknown by the surveyed group, often requiring deception. The second requires that one be able to become involved in some portion of an individual or group's experience. The third hinges on direct observation with no interaction. In this project, I acted primarily as a complete observer but I strived to become immersed as much as possible with my informants. My data collection during the three times aboard fishing boats arose from reactive, direct observation rather than participant observation.

Bernard notes that the advantage of personal interviews are that non-literate informants can participate, clarifications of questions can be provided, open-ended questions can be mixed with structured questions, visual aids can be included, and no time restraints exist (Bernard 1995). Ellen and Bernard's texts are replete with admonitions for the ethnographic researcher to not ask leading questions, recognize status issues related to the affiliation with the researcher, not influence social structures, and awareness of constraints introduced by gender and nationality. Disadvantages of personal interviews include their propensity to be intrusive and the concern that they may elicit undesirable respondent reactions to the interviewer. Bernard (2006) cautions that, "it takes a lot of skill to administer a questionnaire without subtly telling the respondent how you hope he or she will answer your questions" (p. 257). Interviews have the additional, significant disadvantage in that they encumber me with the logistics of locating and visiting the respondents and practical limits on the number of people that can practically be interviewed.

The observational aspect of my ethnographic inquiry was supported by interviews and questionnaires. This project included 65 interviews for Phase I and twelve respondents for Phase II. Validity concerns arise with qualitatively derived data from a small sample size; however, this problem is not new to the social sciences. Weiland (1995) notes the limitations of a sample size observing, “disputes about generalizability will continue in the behavioral and social sciences even as the study of the individual gains in meaning” (p.82). Moreover, the ‘quality’ of the informant is more important than the population in an ethnographic study because informants can lie or fail to fully disclose their knowledge (Bernhard 2006, Denzin and Lincoln, 2000), leading to error in analysis. Bernhard also asserts that identifying key informants is not an entirely methodological process, it requires, “luck, intuition, and hard work” (Bernhard 2006, p. 207). However, the project sought to explore the richness of each interviewed fisherman and boat designer/builder and the quality of survey data was closely monitored, which should mitigate problems with the study.

I employed semi-structured interviews that ask open-ended questions, minimize leading questions and include careful watching and listening. The interviews were done either in English or through an interpreter in Bahasa Melayu or a Chinese dialect. During the interviews, design features were noted, sketched and made three dimensional with clay in order to elicit feedback. Working with sketches and models provided a visual contribution to the semi-structured interview, which is important in clearly expressing technical, non-technical and purely creative elements. The interviews followed the semi-structured interview schedule in Appendix 3.

Clay Modeling

Clay modeling was done by hand and with carving tools, a technique that was helpful in getting immediate feedback and input during fieldwork. I found this technique to be an adjunct to sketching and interviewing, yet I have never read about its use in ethnographic fieldwork. I also found clay models to be helpful when seeking feedback on designs in which I would create boat models in clay and present them with my survey. Clay models are less intimidating than computer generated imagery which has an imprimatur of modernity and precision. In addition, I could simply hand the clay and tools to the informant and let them shape the clay.

One challenge I found with this form of communication was the reluctance of some informants to work with clay as they thought they did not have the requisite skill to achieve their desired form. However, the endeavor was done in a fun environment and I did not encounter any significant problems.

Modeling was accomplished with plasteline clay, an oil based compound that does not harden and can be reused. This clay comes in a variety of colors and hardness ranges of soft, medium and hard. I used green-gray colored soft and medium hardness clays. The soft clay can be worked by hand whereas the hard clay is much like basswood and can only be manipulated with carving tools. I made available a small and large ribbon tool for carving.

Photo 3.1. Informant carving hull design in clay. Kuala Terengganu.

Analysis

My study employs thematic analysis (Bernard 2006, Aronson 1992) which derives from grounded theory initially described by Glaser and Strauss (1967). While thematic analysis derives from grounded theory, it tends to be explanatory rather than striving to develop an overall theory that explains the findings within data. The purpose of this method of analysis is to relate themes identified in interviews, observations and literature; as an inductive tool it requires coded data in order to identify relationships between the data, including triangulation with observations and published literature. Data is assembled into a matrix that relates themes to observations, photographs, exemplar quotations, narrative summaries, and other supporting data.

Interviews were conducted through translators (provided by UTM), wherein I took notes in order to record the data. Occasionally I would dialogue with informants alone using sketches and clay modeling as an adjunct to my rudimentary language skills. The narrations were neither recorded nor transcribed verbatim; rather, the summaries from the interpreter were recorded in a field notebook. Finally, the notes were transcribed and letter codes representing each of the themes presented in Chapter 4 were inserted in the notes. Photographs illustrating a theme were organized in the same fashion. I coded my notes as soon after the interviews as possible to preserve resolution of details that might not be retained if not recorded immediately. The themes evolved with my fieldwork so the early interviews such as at Mersing and Pontian Kecil were coded later. The data that offered methodological triangulation (quotation, narrative summary, observation or photograph) was assembled into a matrix and the connections between themes are detailed in Chapter 5.

Questionnaire for Evaluating Designs

The attractiveness of the resulting conceptual design was evaluated via questionnaire to determine whether I was successful in incorporating the design elements learned from the initial study. The wording and structure of which abided by the guidance offered in both Bell (1999) and Bernard's 'Fifteen Rules' (2006) related to the clarity and validity.

The survey instrument for the Group 3 fishermen was a questionnaire (Appendix 4), available in Bahasa Melayu (also referred to as Bahasa Malaysia) and Mandarin; its purpose was to assess the attractiveness of the conceptual design and was aided by outline drawings and clay models. It was administered by me or personnel from the Department of Fisheries. The verbal administration was very helpful, especially because many of the respondents were illiterate or intimidated by the questionnaire. The respondents were shown three outline drawings and corresponding clay models. The three designs included 1) the visual stereotype (this is the common form and proportions of traditional fishing boats and is described later in this Chapter), 2) a contemporary Western style, deck forward design, and 3) my concept design. Group 3 respondents answered a series of Likert-scaled questions related to the designs performance as a fishing boat, aesthetics, longevity, safety, comfort and ease of maintenance.

I used a control design, which is the visual stereotype, and the contemporary Western style design to bracket my concept design. The visual stereotype represents what the fishermen expect to see in their boats and should have the most non-mechanistic appeal while the deck forward design would be considered to have the most mechanistic appeal from a Western perspective because it provides the largest working deck. Fishermen would be familiar with this design because many of the offshore support vessels for Malaysia's oil industry are of the deck forward design.

The questionnaire results for Group 3 fishermen, without analysis or correlation to demographic data, are presented in Chapter 5. The sampled population size was 20; however, the data presented is based on the responses of 12 respondents. Data from eight respondents is not included and was rejected. I administered the questionnaire to this group myself and they started discussing it among themselves and provided one set of answers; therefore I was unable to extract any correlating demographic information and was unable to identify responses that were unmotivated by the group dynamics. While the data from this group could be instructive, the second phase endeavor was not designed to seek data by any other means than the questionnaire. Adhering to my research plan was important because I had a vested interest in the respondents affirming my design and it was important to ensure that the Phase II appraisal data was minimally processed by me. Because of the unintended consequences of this first effort, I asked Department of Fisheries personnel to individually administer the questionnaire.

I extended the questionnaire beyond the original scope of purely assessing my proposed design concepts, in order to also assess informants' opinions on specific technical issues that arose during my Phase I study. These additional questions related the desirability of specific equipment or design features (presented in Chapter 5). These issues were of interest to my UTM colleagues and may prove to be helpful to the Department of Fisheries also.

Visual Stereotypes

Visual stereotypes represent a culturally shared socio-cognitive schema that frames our expectations and categorizes objects (Kaake and Gulz 2008). A visual stereotype is as a typical exemplar of a concept and defines an object's expected appearance.

A good example of the power of visual stereotype is in American pickup trucks in which the proportions have remained unchanged for over 40 years. Deviations from the visual stereotype can be troubling as the purpose of the design can be unclear and its connection with a particular application (e.g. trucking) becomes confused. A designer must be aware of market expectations and artfully blend the expected form with new and exciting elements. This is as much akin to poetry, in which a new language is not created, but rather exists as an established language used in surprising ways. In the case of boats, the visual stereotype is derived from the proportions, sheer line, bow rake, and stern details. In such a way, identifying the visual stereotype of traditional Malaysian fishing boats provides a basis for comparison in the Creative Product Analysis Matrix (CPAM) analysis. Additionally, where resistance to change is expected, the visual stereotype provides an archetype from which a new design can only gently deviate.

The visual stereotype of a Class B fishing boat comprises factors such as the proportional relationship between deckhouse and hull, relative position of the deckhouse on the hull, sheer line, bow and stern rake. Because the amalgam of these features leads to a stereotype, the data are primarily presented by superpositioning outline drawings. In addition to the overlaid profiles, average bow angles and a curve fit for the average sheer line were calculated.

Within the category of Class B fishing boats, the boats were separated into two additional categories: west coast and east coast. West coast boats were taken by surveying boats in Pontian Kecil and Pulau Ketam, while east coast boats were based upon samples from Mersing.

The methodology employed to obtain the visual stereotype of a traditional Class B Malaysian fishing boat was to identify those that represented commonly appearing profiles. Boats that were to be photographed and included in the establishment of a visual stereotype represented proportions I frequently saw at the docks and this selection was rooted in my experience observing boats. Boats that had highly unusual profiles were also photographed but they were not included in the visual stereotype as described later. I estimated the number of boats that had these proportions and used this to weight its contribution to the superpositioning of profiles.

Boats were photographed with a 10 megapixel camera using image stabilization but no tripod. The photographs were taken of the boat profile from at least 50 meters, in order to reduce parallax distortion. In addition, the perpendicularity of the profile was assured by measuring the corners of the stern and using an estimated beam and the Pythagorean Theorem, the skew was ensured to be less than one degree. In some instances, I was constrained in my positioning so that I was offset by more than one degree. These photographs were not used in establishing visual stereotypes.

The photographs were digitally altered to produce high contrast, at which point they were imported to a computer aided design (CAD) program entitled TurboCAD. In this CAD program the outline of the boat could be drawn over the image. In this manner the photographs were transferred into CAD files that could be easily manipulated. TurboCAD had a tracing utility that purported to automatically outline shapes but I found that it did not work very reliably and I therefore manually drew the boat profiles in CAD.

After the profiles were outlined, they were superimposed upon one another, a process that created the visual stereotype that provided a baseline for my establishment of proportions. The profiles were separated between the east and west coast due to the differing sea conditions (South China Sea vs. Strait of Malacca, respectively). It is important to note that boats serving in the South China Sea are increasingly built on the west coast city of Teluk Intan on the Strait of Malacca, especially in southeastern Malaysia.

The bow angles were taken as an average as measured by the CAD profiles. The equation for the sheer line was developed by using a polynomial curve fit and is based on an 18 meter length overall for the x axis with all boats normalized to this length.

The datum for the sheer was taken where the stem post meets the forward gunwale and all the profiles were scaled from this point to the transom. If a boat was significantly different than that of the typical profiles, it was excluded. While I recognize this is evaluation is subjective, it is rooted in my experience and the boats included in the drawn visual stereotype presentation were excellent examples of commonly occurring profiles while the ones rejected were anomalies. Because there are so few boat designers/builders and because the designs do not change frequently, this resulted in a small number of photographs being superimposed. In the case of east coast boats, ten boats were photographed under the requirements presented above. Seven were included in the stereotype and three were rejected. However, the seven represent the majority of the Class B designs and I specifically tried to find and photograph unusual profiles; therefore the seven to three ratio does not represent a statistical relationship of any sort but is based on my ability to capture accurate profiles and my judgment as to which profiles could be considered far from the norm. In the case of west coast profiles, the visual stereotype analysis is based upon seven profiles, where two were not included because I considered them unusual.

Hull Measurement

I measured the hull form of a representative Class B traditional fishing boat. In addition to providing specific data on hull form, the data was also included in my assessment of visual stereotypes. I supervised a group of three UTM technicians in this endeavor, which took two days to conduct.

The technique for measuring hull form was to develop a grid at ground level comprised of string laid longitudinally and athwarthsips. The string was attached to stakes driven into the ground. Because the ground sloped toward the river, some of the stakes were as tall as one meter. The grid was leveled with a bubble level and the horizontal string grid provided a coordinate plane for measuring vertical heights of the hull at specific stations. Due to the hull symmetry, only one half of the hull was measured.

The intersection of the strings provided reference points for vertical measurements; that is, at each intersection the height to the hull was measured using a plumb bob to ensure perpendicularity to the grid. In addition to these intersections, other critical features were measured at intermediate points to ensure a good representation of the hull form. Measurements were made with a tape measure and vertical axis was plotted against the horizontal plane to develop lines drawings. While I selected the craft to be measured and drew the CAD lines drawing, the three UTM technicians made the measurements and made a sketch lines drawing.

While photogrammetry is a more advanced technique for acquiring this hull form data, the employed method is accurate, flexible and cost effective. Because no other data like this is known to be published, the lines drawing provides comparative data for future studies of design changes in traditional boatbuilding.

Photo 3.2. Surveyed boat

Photo 3.3. Closeup of string grid

Photo 3.4. Measuring verticals from grid

 

Photo 3.5 *Photo 3.6*

Photos 3.2-3.6. Measuring newly constructed Class B Fishing boat. Kuala Terengganu.

Assessment of Malaysian Commercial Design Philosophy

Assessing a cultural design philosophy is difficult to accomplish in a structured manner. Moreover, native designers meld their design philosophy into their creative design solutions which further obfuscates assessment by layering individual expression over the original assessment.

This assessment relied upon observation of the art and design surrounding me during the fieldwork. I also considered the iconic imagery presented on government supported displays such as currency, municipal lighting and architecture. I avoided considering consumer products because most of these products are imported. I focused on potentially dangerous designs such as those related to electricity, fuel, and playgrounds. These designs are strictly regulated in the United States and therefore studying these application provided the strongest contrast with my professional perceptions. My design assessment also included samplings of boat, car and scooter colors.

Creative Product Analysis Matrix (CPAM)

Judging creativity is difficult. In certain fields, the most creative product will provide tangible feedback. For example, when Gutenberg creatively applied the principles of a wine press to the printing press, there was a rapid appreciation for his invention and a new era of civilization was born. In contrast, when evaluating several pieces of artwork, how can one discern levels of creativity? Amabile (1994) offers the following useful *consensual assessment technique* for evaluating creativity:

> A product or response is creative to the extent that appropriate observers independently agree it is creative. Appropriate observers are those familiar with the domain in which the product was created or the response articulated (p. 318).

P.E. Vernon (1989), stated that a creative expression is "a person's capacity to produce ideas, inventions, artistic objects, insights, restructurings, and products which are evaluated by experts as being of high scientific, aesthetic, social, or technological value" (as cited in O'Quin and Besemer 1999, p. 414).

These definitions again reinforce the subjectivity of recognizing creativity while promoting the divisive, and perhaps elitist, notion that only an 'appropriate observer' or 'expert' is exclusively capable of judging creativity. These definitions disenfranchise 'inappropriate observers' from assessing art, music, architectural, and other designs. Judging creativity is also affected by what the creative product is being compared against and by age-related or cultural issues (John-Steiner 2000, Runco 1998, Silvia and Phillips 2004). Concrete or productive creativity are terms also applied to discern the random musings of the mind from some focused product. To approach the contentious issue of evaluating creativity, this study employs the Creative Product Analysis

Matrix (CPAM) developed by Besemer and Treffinger (O'Quin and Besemer 1999).

This study uses the evaluation criterion and rubric developed by Besemer and Treffinger in their Creative Product Analysis Matrix (O'Quin and Besemer 1999). This analysis is based on numerous criteria that evaluate a creative product's newness, effectiveness, and the manner in which the problem is solved. These basic categories are referred to as novelty, resolution, and elaboration and synthesis respectively. Eleven criteria lie within these categories. The individual criteria under the novelty category are original, surprising, and germinal. Under the resolution category are the criteria of valuable, logical, and useful. Finally under the elaboration and synthesis category are the criteria entitled organic, elegant, complex, understandable, and well-crafted. The definition of these terms, in the context of the judging creative output is as follows (O'Quin and Besemer 1999, p. 415):

> Novelty: the newness of the product, in terms of processes, techniques, materials, concepts; in terms of product in and out of the field; in terms of effects of product on future creative products.
>
> Resolution: degree to which product fulfills the needs of the problem situation.
>
> Elaboration and synthesis: degree to which product combines unlike elements into a coherent hole.
>
> Original: rarely seen among products by people with similar experience
>
> Surprising: mind registers startle/shock before evaluation begins
>
> Germinal: likely to suggest other highly original products ('seed')
>
> Valuable: observers believe this because it fulfills needs
>
> Logical: follows established rules within a discipline
>
> Useful: well-recognized practical application to its field

Elegant: refined and understated

Complex: variety of elements are combined at one or more levels

Understandable: clearly communicated

Well crafted: worked and reworked with care

Organic: the creation employs irregular shapes that reflect natural rather than mechanical shapes. (While included in the CPAM matrix, this definition was not provided by Besemer and Treffinger's CPAM description.)

The CPAM method will be employed in this study to evaluate the creative value of boat designs. While this analysis helps to characterize creative aspects of a design, one must recognize that any attempt at quantifying creativity is imperfect. The ability to assess creativity is also affected by other insidious forces. For example, the assessor's relationship to the product influences the judgment, which is a particular concern in this study because I am accessing my own designs. This matrix shows direct shortcomings, for example, decorative treatments to a product would result in a 'low' rating in the 'useful' category. One could also argue that certain products (e.g. military weapons) have a negative usefulness. Additionally, a surprising design may not necessarily aesthetically attractive. In this study, the well crafted category is not considered because the boats are not actually produced. These shortcomings notwithstanding, the CPAM works reasonably well for physical products, developed by adults, and without a broad view of the meaning of usefulness.

Anthropometry

Anthropometric data provides detailed dimension on the human body and considers range of motion. Anthropometric data is obtained by measuring devices that capture dimensional and reach information. Reach information can consider such factors as strength reduction as a function of distance from torso, dexterity requirements, and biomechanical restraints on motion. Anthropometric data also includes visual line of site information that is helpful in locating instrumentation and human control inputs.

The data used for this study are based upon studies by NASA and in Malaysia. The Malaysian study provides data on measurements of 226 Malaysian Malays, Chinese and Indians. A summary of the data is provided in Table 3.1 (Deros et al. 2009). Figure 3.1 represents neutral body posture based on NASA data (Anthropometry and Biomechanics 1995).

Table 3.1. Fundamental Sitting Anthropometric and Differences among Malaysian Malays, Chinese, and Indians (Deros, Daruis and Nor 2009, p.172).

Dimensions	Male					
	Malays		Chinese		Indian	
	Mean	SD	Mean	SD	Mean	SD
Stature	1685.8	54.8	1720.8	51.6	1752.2	30.3
Interscye breadth	379.5	46.5	348.8	36.5	395.6	15.1
Hip breadth	363.8	63.3	342.5	31.1	423.3	35.0
Sitting height	864.6	50.7	871.7	51.5	874.4	13.3
Sitting elbow height	211.8	42.3	213.1	42.4	190.6	20.4
Seat height	450.2	38.6	429.6	19.2	440.6	30.3
Thigh clearance	193.4	48.7	187.6	32.5	162.2	23.3
Upper leg length	563.1	38.3	569.5	25.5	561.7	50.1

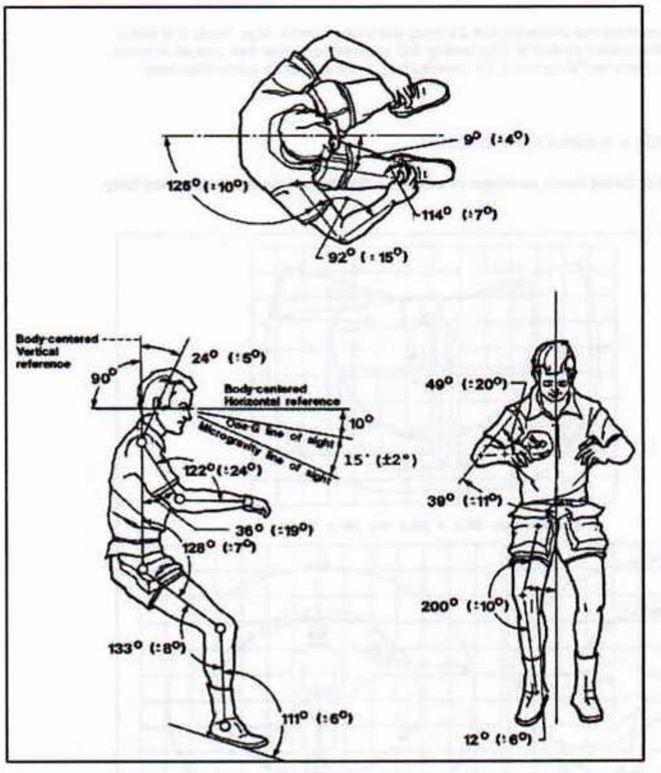

Figure 3.1. Neutral position (NASA 1995, p.34).

Published anthropometric data is used to develop the helm design for my boat designs. The helm design is intended to allow operation of the boat while maximizing the neutrality of the helmsmen's position. In addition, the helm is designed to optimize line of sight angles for instrumentation, ensure that all controls fall within the grasp of reach parameters, allow the helm to be used while sitting or standing, and permit easy access of the throttle controls from the deck.

Positionality

The goal of this study is to gain insights into boat design and then synthesize these insights into a new, culturally appropriate design. Additionally, the goal is to study a specific design within a specific community with which I was unfamiliar. This endeavor was pursued so that I could more fully set aside my preconceived notions about boat design and optimal design approaches in order to replace these preconceptions with data from the study. However, I work from a distinctive interpretive community and my positionality can bias my epistemology; therefore, commentary on my positionality is necessary.

Qualitative research methods, certainly those deriving from phenomenology and grounded theory, appreciate the assertions of hermeneutical phenomenology in that people generally interpret data based on historical and cultural perspectives. These methods inductively derive conclusions from data. Ethnography as a method requires rapid processing of data in the field and the data must be acted on quickly in ethnographic exploration. Mason (2002) notes that “qualitative research is characteristically exploratory, fluid and flexible, data-driven and context-sensitive” (p.24).

My ethnographic study faced the dilemma of qualitative research, namely this study must “assume that qualified, competent observers could with objectivity, clarity, and precision report on their own observations of the social world, including the experiences of others” (Denzin and Lincoln 2000, p. 22). Attempts to gain insight are filtered through the lenses of language, gender, social class, race, and ethnicity. Objectivity can only be considered in the socially situated context of observation (Denzin and Lincoln 2000). Bateson presents one of the most honest affects of researcher’s ego in asserting the researcher is “bound within a net of epistemological and ontological premises which – regardless of ultimate truth or falsity – become partially self-validating” (Bateson 1972, p. 314 as cited in Denzin and Lincoln 2000, p. 19).

My Western enculturation influence my observations and the boat designs that I develop. Self-awareness of this vulnerability helped mitigate these factors (Bernard 2006). Bell (1999) and Bernard (2006) advise researchers to accept subjectivity and advise them to disabuse themselves of the notion that "objective knowledge can be pulled from the thicket of subjective experience" (Bernard 2006, p. 371).

Because I was the instrument of my epistemology, recognizing my perspective is important element in validating this work. As discussed previously, my academic training is largely in the positivist tradition; moreover much of my professional work has required stronger quantitative rather than qualitative approaches. However, my professional work as a designer and my previous graduate studies have drawn on qualitative approaches. When faced with the proverbial blank piece of paper, I have been more likely to start with a hunch rather than an equation. The tentative first approaches to design draw upon the marketing brief but soon many design influences, both quantitative and qualitative, act upon the evolving design. Therefore, in this project I brought some ability to intuit the stability, seaworthiness and other boat behaviors but I was unable to identify all the design factors. By studying design in a different culture, my study was framed so that I could not draw from my Western cultural perspective in the same way I could rely upon my quantitative skills. Therefore I had to actively oppose my inclination to characterize every feature mechanistically and to keenly observe and inquire about design features. This drew me out of my comfortable element of engineering into the less comfortable realm of ethnography. The approach to my research had to move from learning facts to understanding perspectives.

Bias and Ethical Considerations

Bias

This project is vulnerable to bias from many sources. The most likely biases are: 1) acquiescence, 2) social desirability, 3) sampling, and 4) theoretical. Acquiescence is the propensity for respondents to agree with all questions at least those with a positive connotation. For ease of use, my Likert-scaled questionnaire was always ranked from 1 being ‘strongly disagree’ to 5 being ‘strongly agree’. Therefore respondents could, for example, simply put ‘strongly agree’ for all responses. Social desirability bias is the description of respondent’s tendency to reply to questions that will carry favor with others. The questionnaire was confidential but this bias could arise, specifically when asked about particular design features which they may view as the ‘correct’ answers. For example, who does not want a life raft?

Bias can also be introduced into this project by relying upon non-representative sampling based on informant and site selection. My informant selection can contribute to skewed sampling and I recognize that I cannot guarantee that interview information represents all possible experiences or cultural perspectives. Additionally, the interview locations can contribute to sampling bias. While the locations were based largely on my ability to access the communities by personal automobile or taxi, they were largely clustered around my home base in southern Malaysia and the boatbuilding communities of northeastern peninsular Malaysia. Consequently these sites cannot be guaranteed to represent the entire cultural community. The location issue is further exasperated by the ethnic and cultural differences between the Malay and Chinese Malaysians who tend to cluster in different communities.

Theoretical bias can also be introduced to this project because I quickly recognized by observation that the traditional Malaysian fishing boats were not designed to encounter green water and this provided an early assumption in my research. This conclusion could lead to too tightly focusing on this aspect of design. In a broader sense, I was encumbered by my engineering education and experience to seek quantitative answers or design solutions derived by controlled experimentation. I had to consciously work towards identifying qualitative ethnographic data that was far removed from the laboratory and extract data from sometimes meandering interviews.

One of the primary factors affecting bias is my position as an American designer/lecturer, which had the potential for informants to seek social status by affiliating themselves with me or, conversely, avoiding me due to disagreements with American policies. Malaysia has had conflicts with European Union (EU) authorities over fishing boat sanitation and fish handling that could influence the cooperation of informants with a Westerner. In addition, a Malaysian could take offense at Americans for a variety of reasons but one of the most prominent may be policies in connection with Israel. Malaysia does not issue visas to Israelis and is aligned in this policy with many Muslim nations.

While these biases may be transmitted into the results, I have endeavored to minimize bias and approach objectivity in my work. I further discuss significant bias findings in Chapter 5.

Ethics

Because my project can be beneficial to a community of practice, an elaboration on how these affects might arise is presented in the following section. Bernard (2006), Bell (1999) and Cohen, Manion and Morrison (2000) provide ethical considerations for the researcher that are relevant to this particular project. Some of the ethical concerns that may arise from my study are 1) social implications, 2) economic implications and 3) detrimental effects of my study. The groups potentially affected by this project are 1) boat designers/builders, 2) boat owners, 3) fishermen, and 4) UTM colleagues.

Boat designers/builders could be affected by this project if I uncovered harmful information such as design shortcomings or construction 'shortcuts' among the boat designers/builders whom I observed, interviewed and, in one case, whose boat hull was measured. However, I found no resistance to my inquiries, photographs and measurements. The boat designers/builders were eager to show me their work even when the workmanship was what I considered low quality. In order to disseminate the information, boat designers/builders, as well as the Department of Fisheries, received a copy of the concept boat. Additionally, a copy of the measured lines drawings were sent to the boat designer/builder who allowed me to measure his hull.

Additionally, boat owners might be impacted by this project's findings, notably those regarding falsifications of design that lower GRT, which has licensing and economic advantages to owners. The owners could be further impacted by this project if it was an instrument of regulation which mandated safety equipment that would affect operating costs to the owner. While auditing safety equipment is not the goal of the project per se, this study found that safety equipment was generally lacking among boats. The fishermen share some of the concerns of the boat owners because their livelihood is dependent on the prosperity of the owner. However, fishermen may have a propensity to amplify the lack of safety equipment or comfort facilities because they feel that this project would be a conduit for change. The informal market is also important to the fishermen, which involved at a minimum reselling subsidized fuel and keeping some of the fish harvest.

Because the interviewed fishermen were not compensated, this work will not be detrimental to the social or economic fabric of their community. I generally encountered no resistance to the free flow of information and I did not detect any concern with my work threatening their livelihood. I was self-censoring regarding sensitive topics such as reselling subsidized fuel. Also, I was aware of EU directive that banned Malaysian fish imports due to lack of sanitation onboard, but my assurances that I was not involved with any regulatory investigation were largely accepted.

The guidance I received from my UTM colleagues potentially could be influenced by their concern that Malaysian fishing boats or fishing communities could be shown in an unflattering manner. However, my UTM colleagues' awareness of Malaysia's status as a developing nation was transparent. While not asserting that Malaysia was thoroughly 'modernized', they realized that Malaysia was capable of fully embracing advanced technology and not encumbered by traditional aspects of their culture or economy. They further recognized they were straddling an evolving economy but the nation had intellectual and technical abilities on par with Western societies. The lack of technical development within fishing boats and the poor economic conditions of fishermen are recognized by Malaysian scholars and government officials so I do not think my UTM colleagues were concerned with the threat of a new, embarrassing discovery arising from my project. I also prepared some of my findings from this project for publication of faculty research at UTM and also provided them my digital photographs.

This project was pursued in order to learn and contribute to the field. However, embedded in this work is a pride of ownership for my design and my findings, which have the potential for disruptive affects. I am compelled to believe my approach to the project and the conceptual design are the best possible product. Therefore, I will have a tendency to deflect criticism or resist integrating culturally appropriate design features that I dislike. While my design employed the established design elements of proportion, movement, balance, and rhythm, I strived to let the data speak through my design. This deference to my analysis has reduced my creative contributions to primarily the incorporation of iconography, while respecting the current visual stereotype and traditional proportions. I have bridled myself in terms of introducing aesthetics that are attractive to me and as a result the boat design probably does not reflect a ‘brand name’, ego driven approach to styling.

I do not think my design will be fully adopted by boat designers/builders as some brilliant execution of culturally appropriate design. Boat designers/builders resist change. Their profession is connected with their traditional knowledge of construction and their reputation for boat performance and durability. Moreover, sociological forces of group identity connect designs to the builder/designer’s status. However, if my concept design were developed as a speculatively built boat with a cost below traditional boats, my project could have a detrimental economic affect on the boat designers/builders. I believe this business model, perhaps with government subsidy, is the best way to introduce this design concept. There already exists FRP fishing boat production in Malaysia and the boat market is international; therefore, non-traditional fishing boats are already available to potential boat owners. Moreover, it is presumptuous to think that a government subsidy of a more efficient and safer boat would be fully directed at my design. Rather, my design could be a starting point or an independent voice for Malaysian naval architects to design a Class B fishing boat.

Finally, if this project produces an all weather design that can fish during the monsoon season, the sustainability of the fisheries could be harmed. Protecting fish species during spawning is important for long term vitality. If the concept design allows for overfishing where traditional craft are self limiting by their seaworthiness, the deleterious effects will need to be managed by regulation and enforcement.

Validity

In order to provide meaningful advancement of understanding, findings deriving from qualitative research must be held to standards of validity. Internal and external validity, reliability, neutrality, generalizability, and capacity for replication are common standards for rigor in empirical research (Cone and Foster 1993). Categories more appropriate for ethnographic studies are proffered by Bernard (2006) and Lincoln and Guba (1985). Lincoln and Guba parse validity for qualitative studies into the concepts of *credibility*, *transferability*, and *dependability*.

Credibility is similar to internal validity and describes the believability of findings to the stakeholders. Transferability describes the qualitative finding's ability to be generalized and applied to other situations. The transferability concept parallels the notion of external validity. With small sample sizes, the ability to generalize findings and apply them to populations that were underrepresented in my study becomes difficult.

An audit trail that promotes dependability is included in this project in the form of informant data, method of data collection, questionnaire schedule, and other descriptive material. However, ethnographic studies may be difficult to duplicate because people act differently under different situations and their responses cannot be controlled. The concept of neutrality does not apply well within the framework of an interpretivist epistemology and qualitative data can only be taken in the context of the positionality of the research. The biases described previously arise in ethnographic data in a manner that cannot be extracted by analysis. Biases must be acknowledged and ethnographic objectivity can be approximated by understating the possibility of bias in data and interpretation.

The design of this study allows methodological triangulation between data obtained by interviews, observations, photographs and literature as well as data triangulation by sampling over a wide geographic region and among both Malays and Chinese. Fundamentally, the validity of qualitative study depends on the collective opinion of researchers (Bernard 2006). In this study, validity is inferred by the successful application of data in my new boat designs. That is, the data obtained in this study during Phase I are incorporated in my design and then assessed in Phase II. If my design is viewed by Group 3 informants as useful, this suggests my Phase I data was valid. However, there is more to my design than applying Phase I data, the main goal of which is to include creative expression into the design within the constraints of the Phase I data. If there exists strong resistance to change and a very powerful visual stereotype than I would be unwise, in the role of a designer, to deviate far from existing boat design.

Reflections on Methodology

Ethnography strives to extract truths based on holistic, sensitive and richly detailed subjective appraisals of small populations. Moreover, it allows the research to incorporate personal experience into the process. Ethnography is an active form of research that requires the researcher to respond to variables like changing mood of the respondent, non-verbal behavioral cues, and sensitivity to ethical constraints. All the while, the ethnographer must be aware of this influence on respondents' behavior and how it might skew results. Observation and interviews are powerful, practical approaches for acquiring data, particularly as related to the culturally specific non-mechanistic elements of design.

CHAPTER 4

PROJECT ACTVITY

Background

During the project fieldwork, I completed Phase I and II activities which resulted in a boat design concept that was evaluated by fishermen. The findings from this project activity were used in my creative design work which strived to avoid being simply self expression but rather one that integrates ethnographic data and analysis into a transdisciplinary-based design. The concept design reflects the demands of stakeholders and incorporates creative expressions that synthesize functional elements, such as overall dimensions and stability with enticing stylistic and non-mechanistic attributes. Additional activities during the project included the development of lines drawing of a newly built Class B fishing boat in Kuala Terengganu.

Scope

This study was primarily focused on Class B traditional fishing boats. Class B boats are those built under 40 GRT (gross registered tonnage) and are limited to offshore fishing from 5 to 12 nautical miles from shore. During monsoon season the boats can apply for an additional license that allows them to operate within 5 nautical miles for prawn. These boats are commonly made using traditional techniques from the tropical hardwood chengal (*neobalanocarpus heimii*).

Investigations at Universiti Teknologi Malaysia (UTM)

I received a UTM appointment as a Visiting Professor (Faculty of Mechanical Engineering, Marine Technology Department) for the summer and autumn of 2009. UTM provided office space, translators, measuring equipment, transportation and access to unpublished theses. The cooperation of UTM was offered in response to a letter of cooperation sent by the Provost of my institution. I taught a three day marine surveying at UTM with the proceeds from this course used as an internal UTM funding source (although it did not cover all expenses). My faculty appointment at UTM requires that I provide consultation, research, and publication of my work related to fishing boat design (reference Appendix 2). To respond to this obligation, I have submitted a report based on this project to UTM. Ethical considerations in connection with my UTM affiliation will be dealt with later in this Chapter.

Fieldwork

I arrived at UTM in Skudai, Malaysia in June 2009 and left in November 2009; however, my fieldwork was conducted from July through October. I observed and interviewed Malay and Chinese fishermen and boat owners on both the South China Sea and the Strait of Malacca. Specifically, I interviewed informants at Pontian Kecil and Pulau Ketam on the west coast and Cherating, Endau , Kota Bharu, Kuantan, Kuala Terengganu, Mersing, Sedili and Tumpat on the east coast. I was living in Skudai, north of Johor Bahru, which is located between Pontian Kecil on the west coast and Mersing on the east coast. I did not visit the northeast coast, most significantly I did not visit Teluk Intan, which is a large boatbuilding community. My investigation was during the non-Monsoon season, therefore the fishermen and boats I encountered at the docks were not disproportionally those who would tend not to go out in high sea states.

I also studied river boats on the Lemanak River in Sarawak and the Tembeling River in Pedang. These boats are used by the indigenous peoples of Borneo and peninsular Malaysia respectively. Reference Figures 4.1 and 4.2 for maps of locations.

My initial fieldwork was done in cooperation with two UTM faculty members, a UTM technician and a doctoral student. We visited Mersing, inspected a Class C boat and visited a repair facility. Our conversations with fishermen and repair personnel were my first glimpse of the culture outside of published literature and conversations with my fellow lecturers at UTM. All my other fieldwork was done only with UTM translators, technicians or by myself. When I visited fishermen, I was thought of as a European and my children were sometimes described as 'European' rather than white or American because Malaysia seems to have more contact with Caucasian Europeans than Americans. Malaysia has had disagreements with European Union (EU) authorities over fishing sanitation and the US and Europe over political issues, primarily relationships with Israel. However, I never encountered any hostility during my fieldwork. The only time I was obviously handled differently was when I docked with a trawler at the offloading dock in Kuala Terengganu. In this instance, I believe they did not want me to see how the fish were handled, due to the EU sanitation concerns described previously, or any economic exchanges. However, this is conjectural. Interestingly, I had spent several days at this dock without a problem so this one occurrence was an anomaly.

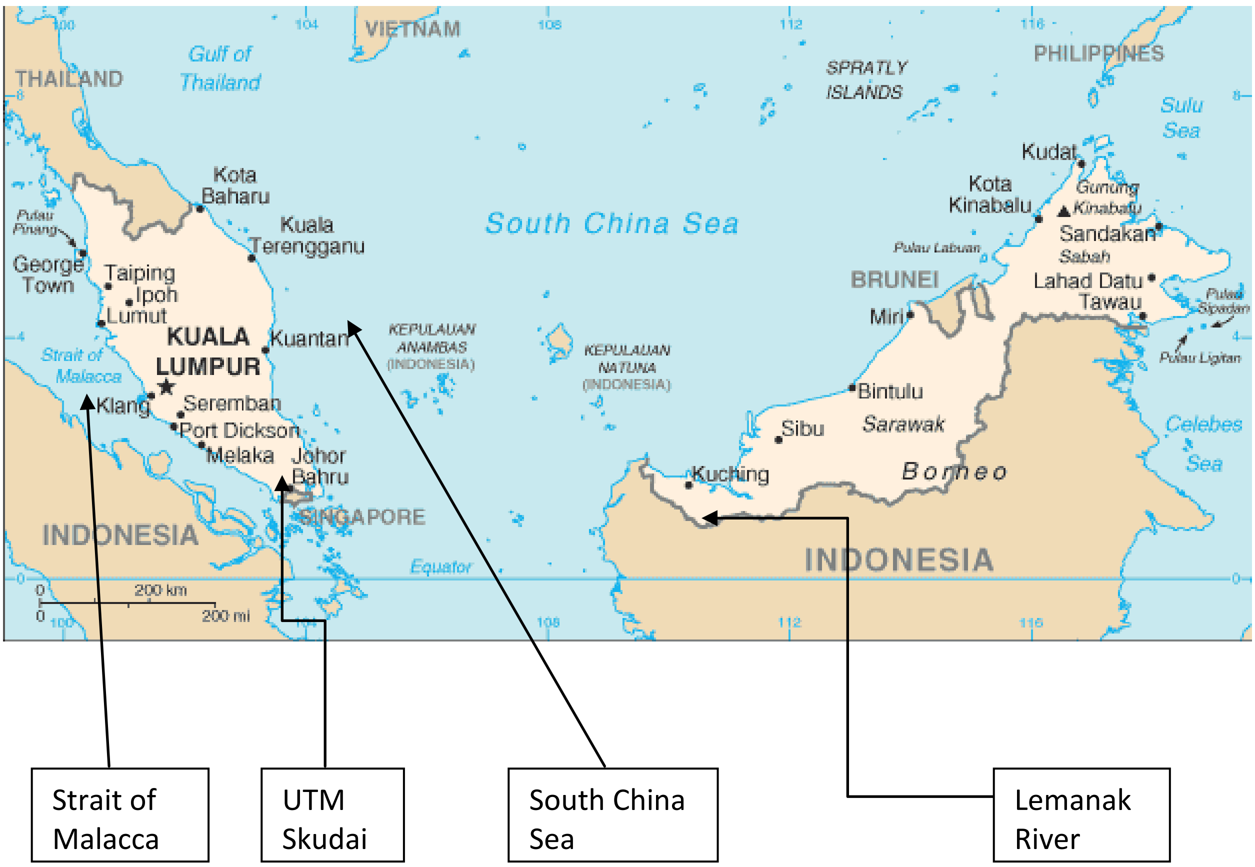

Figure 4.3 Significant features in Malaysia

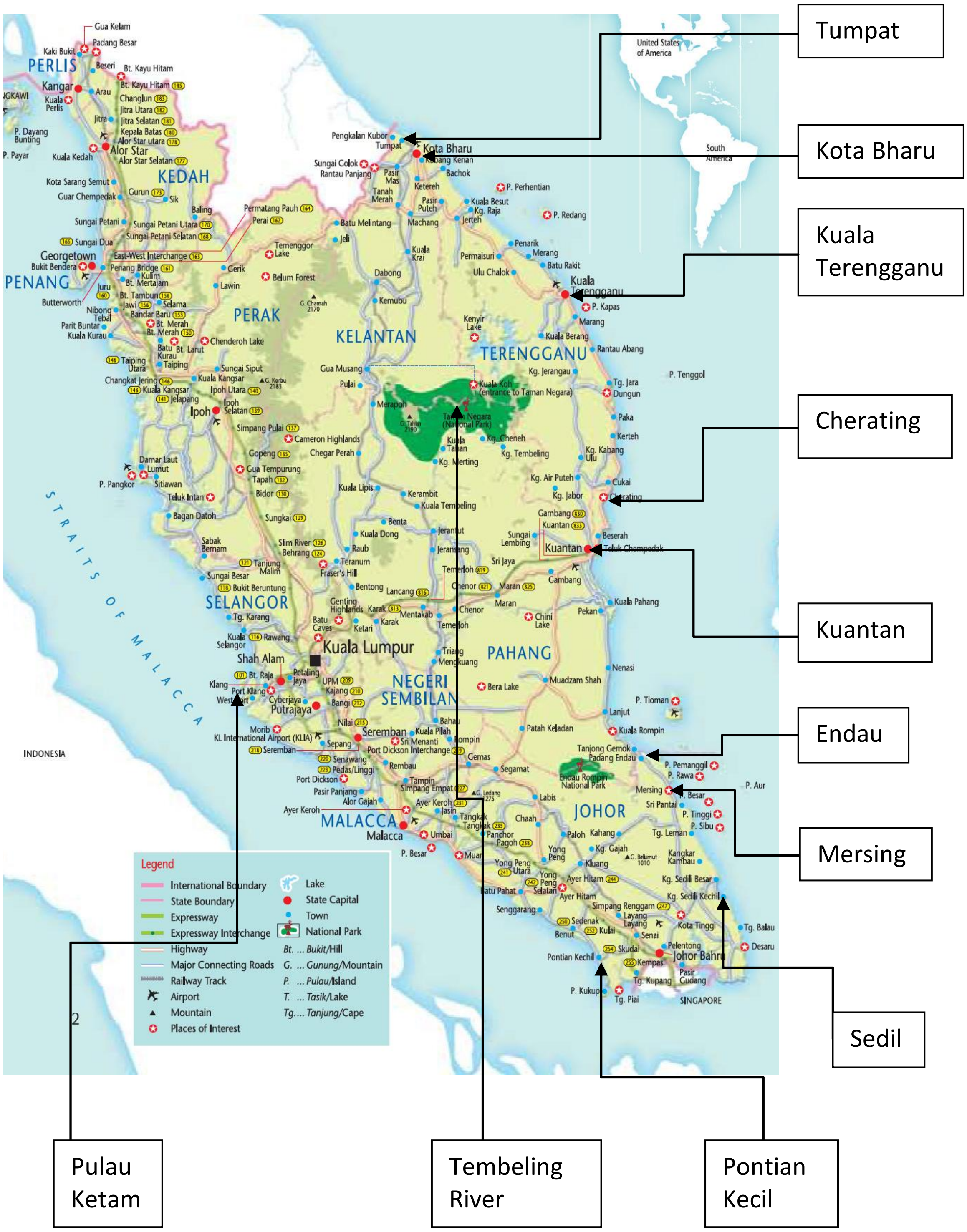

Figure 4.4 Site visits in peninsular Malaysia

Demographics

All the fishermen, owners, brokers, designers/builders, repair personnel were male. The only women I saw in connection with the fishing industry were three women who worked in staff positions at the Department of Fisheries in Mersing.

The following statistical summaries are extracted from Selected Social Statistics (2009). Fishing is a minor sector of the economy with only 1.1 percent (120 900) of employed persons involved with fishing industry. Labor force participation for males across all sectors of the economy declines rapidly for men in their 50s, from 70.4 percent in the 45-54 age group to 45.0 percent for the 55-64 age group based on 2007 data. Labor force participation is nearly the same for all ethnic groups (Selected Social Statistics 2009). In this study, there was a dearth of informants in their 30s and upper 20s for all populations.

Ethnic Groupings

The primary ethnic groupings on peninsular Malaysia are Malays, Chinese, and Indians. Political parties form largely around ethnic identity. Malaysia is actively pursuing policies that instill a sense of nationalism and minimize the separation of the ethnic groups. The government prosecutes individuals who attempt to instill ethnic conflict and have a large promotional campaign called *1Malaysia* that uses modern advertizing methods to instill a communal sense of nationalism.

The largest and most politically powerful ethnic group is the Malays who comprise 53.3 percent of the Malaysian population (US State Department, n.d.). The Malays are Austronesians, an ethnic group that extends through much of Indonesia and the Philippines. The Malaysian constitution requires those identified as Malays to be Muslims. The Malay's language has been officially renamed *Bahasa Melayu* (although I always heard it referred to as *Bahasa Malaysia*) to provide an appearance of inclusivity to this official national language.

Indigenous people in peninsular Malaysia are referred to as Orang Asli (or Orang Laut for those living by the sea). In 2003, 147 412 lived in peninsular Malaysia, which is only 0.7 percent of the total peninsular population (Center for Orang Asli Concerns 2008). Many more indigenous people live in eastern Malaysia, on Borneo, which brings their total population to 11.8 percent of the Malaysian total. Malay and indigenous people are referred to in government statistics as Bumiputera (princes of the land) and grouped together.

Chinese Malaysians are primarily immigrants from south China and comprise 26.8 percent of the Malaysian population. A history of conflict exists between the Malays and Chinese leading to the separation of Singapore from the Federation of Malaya and violent conflicts during the 1960s. The most common Chinese dialects are: Mandarin, Cantonese, Hokkien, Hakka, Teochew, Hainan, and Foochow.

The Indian population are primarily Tamil from southern India and speak the Tamil language. While Indians are 7.7 percent of the population, I never met any Indians involved with fishing in the areas studied.

Locations

The following summarizes the locations investigated in connection with traditional fishing boats. These included all the boat building sites except Teluk

Intan in the state of Perak. I also studied boat design interconnections in the states of Pahang and Sarawak but these were not directed towards Class B fishing boats. The Malaysian fishermen population can be differentiated by ethnicity (Malay and Chinese) as well as operating areas (South China Sea and Strait of Malacca). Reference Figures 4.1 and 4.2 for maps of locations.

The following population and ethnic statistics derive from the Malaysian National Census 2000, Department of Statistics, *Selected Social Statistics*.

State of Johor

Population: 2,740,625

Ethnic Composition: Bumiputera: 57.1 %, Chinese: 35.4 %, Indian: 6.9 %

Southeast Johor (South China Sea)

Endau: Endau is a fishing village centered on the Endau River 33 km north of Mersing. Boatbuilding is no longer active in Mersing, however they do have a repair facility.

Mersing: This fishing village is located on the Mersing River on the west coast. The village has mixed Malay and Chinese crews. This town has many new buildings and a large construction project was underway along the riverfront during the time of this study. Mersing is a major city along the eastern highway route and also a popular embarkation point for tourist travel to the Seribuat Archipelago.

Sedili: This small mangrove encircled village consists of traditional wooden homes and buildings and supports a small fleet of fishing boats. It is located in the southeastern edge of the state of Johor

Southwest Johor (Strait of Malacca)

Pontian Kecil: Located on the on the west coast, this community harbors primarily Chinese owned and crewed boats. Boat building has been done here in the past but the builder had not been active for many years and was involved with boat repair only.

State of Selangor

Population: 4,188,876

Ethnic Composition: Bumiputera: 43.5 %, Chinese: 35.7 %, Indian: 19.6 %

Pulau Ketam: This island is on the west coast and is the home of one traditional boat designer/builder. This community has a large fishing fleet and homes and walkways are elevated on stilts. The island can only be accessed by a boat but is only about a 1 ½ hour ride by train and boat from Kuala Lumpur.

State of Pahang

Population: 1,288,376

Ethnic Composition: Bumiputera: 76.8 %, Chinese: 17.7 %, Indian: 5.0 %

Kuantan: Located on the Kuantan River on the east coast with a largely Chinese owned fleet. Kuantan is a large city with a population of 607 778 and is the capital of the state of Pahang. Kuantan supports a large fleet of fishing boats and includes a large repair yard as well as a FRP boat builder.

State of Terengganu

Population: 898,825

Ethnic Composition: Bumiputera: 96.8 %, Chinese: 2.8 %, Indian: 0.2 %

Kuala Terengganu: Located on the Terengganu River on the east coast and is composed almost entirely of Malay. This city has a population of 396 433 and is the capital of the Terengganu state. This is the center of traditional boatbuilding on the east coast. I visited five traditional boat designers/builders and one modern ship yard in Kuala Terengganu. This city also provides support facilities for the offshore oil fleet.

State of Kelantan

Population: 1,313,014

Ethnic Composition: Bumiputera: 95.0 %, Chinese: 3.8 %, Indian: 0.3 %

Tumpat and Kota Bharu: Located on the northeastern portion of peninsular Malaysia. Like Kuala Terengganu, this area is largely Malay and has historical connections with Thailand. Buddhist wats are scattered through the area. Kota Bharu is the capital of this region. I visited one active traditional boat designer/builder in this area. I visited another location on the Thai border that was formerly a boat building site but it was no longer active, although boat repairs were still being done.

Semi-structured Interviews

After the preliminary fieldwork at Mersing I developed a semi-structured interview schedule for fishermen and boat designers/builders. The semi-structured interview schedule is presented in Appendix 3.

The interview was organized along the following categories: technical, long term motivators, fishing motivators, aesthetics, and boating community interactions. The questions were open ended and were supplemented with active drawing and clay modeling. These visual approaches were helpful in clarifying statements and expressing technical and aesthetic details. The most common venue for the interviews was at or near the docks.

Group 1 informants were comprised of six traditional boat designers/builders, which represent nearly all the active traditional boat designers/builders with the exception of Teluk Intan. I also observed, but did not interview, one Kuala Terengganu wooden boat builder because he used skeleton construction for very small boats. Additionally, I interviewed four boat repairers, one of whom previously built boats. Although this may appear to be a small sample I spent considerable time in observation and consequently gain invaluable insight into processes and key design elements that guided my future observation and interviewing.

Group 2 informants were comprised of 41 fishermen working aboard traditional fishing boats. I interviewed fourteen additional informants who were connected with the fishing or boat building industries. The observations ranged from studying fishing boats at dock to a one day trawling observation offshore Kuala Terengganu. I was aboard two other fishing boats and also investigated river canoes to gain insight into modifications made in response to new technology (specifically outboard engines).

Of the Group 2 informants, I interviewed three boat owners and 14 fishermen (including three who owned their boat) in a structured manner. I interviewed a further 27 fishermen in a less structured manner, meaning that I did not address all the points in my questionnaire schedule. Additional interviews that did not fall into any of my three populations (Group 1, 2, or 3) included six Department of Fisheries personnel, one fish broker, three managers of a commercial shipyard and one German owner of a traditional boat converted to his live aboard yacht. All the informants were cooperative, some even providing automobile and scooter rides to different locations. They never wanted to rush through the interview and I did not find resistance to my questions. One of the informants (a non-fishing boat owner) did not want to give his name even after I assured them of the confidentiality of my inquiry. All other informants were readily willing to give me their names. Some also wanted to provide phone numbers and national identification numbers, even though this data was unsolicited. I recorded ethnic identity based upon name, not visual appearance. Interviews that were not conducted through translators were conducted in English, rudimentary Bahasa Melayu and the help of drawings and clay models. At Pontian Kecil, Mersing, Kuala Terengganu and Sedili, the interviews were conducted with the aid of UTM translators using Bahasa Melayu and Chinese dialects.

Listings of Group 1 and 2 informants are given in Appendix 5.

Themes

During early interviews and observations, themes evolved which would provide a framework for additional ethnographic study and later interpretation. The following presentation provides an outline of the theme categories and highlights data obtained. The interpretation of this data is provided in Chapter 5.

The following themes evolved from my interviews and observations:

Mechanistic

Green Water
Sea State
Sheer
Bow Shape
Cross Section
Freeing Ports
Hatches
Appurtenances

Non mechanistic

Personal Safety
Aesthetics
Resistance to Change
Economic Goals
Boating Community Interactions

Data in connection with mechanistic themes were primarily obtained by observation of design details while the non-mechanistic theme data was primarily acquired by interviews and direct observations of behavior. Data from interviews and observations as well as photographs were coded according to themes. The data summary for each theme contains representative examples of supporting evidence in the form of examplars and published data from outside this study that triangulates the evidence. The informant code, as indicated in Appendix 5, follows their statements in parenthesis. The informant code for Phase I is a letter or letters indicating location (e.g., M = Mersing) and a sequential number. The informants used in Phase II have a number '2' preceding their code (e.g. 2M).

While only examples of supporting data are included, all opposing data are shown in the data summary because coherence is a key evaluative criterion and therefore all contrary data are comprehensively identified (Madison 2005). Where data must be arrived at primarily through interview, such as boating community interactions and resistance to change, more examplars are included than with other themes. The interpretation of thematic data are discussed in Chapter 5.

Theme Definitions:

Green Water:

All design features or commentary related to either preventing green water from coming onboard or draining or blocking it once onboard.

Sea State:

All design features or commentary related to sea conditions, particularly waves.

Sheer:

All design features or commentary related to sheer line of boat, particularly how this relates to seaworthiness and affect on handling fishing gear.

Bow Shape:

All design features or commentary related to the design of the bow, especially as it affects seaworthiness.

Cross Section:

All design features or commentary related to the form of the hull excluding the bow. The cross section shape affects the motion of the boat in waves.

Freeing Ports:

All design features or commentary related to draining water off the decks, whether from green water, water discharge hoses or rain.

Hatches: All design features or commentary related to hatch features or operation.

Appurtenances:

All equipment or commentary used for operating the boat or fishing. Specific equipment was not the focus of the study therefore machinery data was not actively investigated.

Personal Safety:

All design features, equipment or commentary related to crew protection.

Aesthetics: All design features or commentary related to boat aesthetics.

Resistance to Change:

Commentary and design features related to resisting change in boat design.

Economic Goals:

Commentary related to financial prosperity or fishing sustainability.

Boating Community Interactions:

All commentary or artifacts that relate to the fishermen's culture and their interactions with each other and their society.

Theme: Green Water

Narrative: Some direct statements related to green water can be contradictory such as M1 stating he rarely takes on green water to S2 stating they take on green water. Therefore, concerns for green water and the actual presence of green water are more directly inferred by design features such as freeing ports, hatch design and sheer, presented later. However, the transom thickness of the measured boat was 46 percent undersized according to typical scantling rules (see Photographs 4.1 and 4.2). Photograph 4.3 shows unsecured fish trays on a deck, which indicates lack of concern for green water but the other themes are better indicators.

No green water was encountered on my boat travels; however, I was never offshore in high sea states. I did encounter steep seas entering one estuary but none came onboard.

Photo 4.1

Photo 4.2

Photos 4.1 and 4.2. Undersized transom planking on new Class B fishing boat surveyed in Kuala Terengganu.

Photo 4.3. Unsecured fish trays on Class B trawler foredeck. Kuala Terengganu.

Theme: ***Freeing Ports***

Narrative: Freeing ports are used to quickly drain water from the deck. The west coast boats typically employed a series of small holes while east coast boats commonly included larger oval portals.

Summary: Freeing ports are undersized for draining green water and are smaller than prescribed by IMO (International Maritime Organization).

Supporting Data:

- Freeing port area for measured boats is less than 9 percent of the recommended IMO values.

Opposing Data:

- o Freeing ports work well (S2).
- o Dangerous conditions arise if fish plug the freeing ports (P3).

Supporting Photographs:

Photo 4.4. Freeing ports. Pontian Kecil.

Photo 4.5. Freeing ports on new Class B fishing boat surveyed in Kuala Terengganu.

Photo 4.6. Freeing ports draining water from deck washdown. Pontian Kecil.

Theme: ***Hatches***

Narrative: No hatches were sealed but holds were fit with coamings and hatch covers were held over these coamings by their weight. Hatches were tilted off by hand and pivoted around the coamings. The coamings keep deck water out of holds however there were no design features, besides the mass of the wooden hatches, that prevented a large incursion of green water from floating the hatches out of position.

Summary: Hatches are unsealed and no informants reported water incursion from hatches.

Supporting Data:

- Never had problem with water entering forward holds (P1).
- Do not meet standards for hatch design (IMO).

Opposing Data:

none

Supporting Photographs:

Photo 4.7. Hatch detail, new Class B fishing boat. Kuala Terengganu.

Theme: ***Sheer***

Narrative: Higher sheer at the boat ends provides reserve buoyancy and also reduces green water on deck. The sheer is also an important aesthetic element in defining the lines of the boat. However, high sheer increases windage of the hull and can make working over the gunwales more difficult, especially at the stern.

Summary: High sheer at bow, which reduces propensity for green water incursion.

Supporting Data:

- Never get water over bow (KB1).
- High prow needed to keep waves out (K3).
- Want high bow for going offshore, not on the rivers though because it blocks your view and you have to be able to see what is ahead of you on the river (C1).

Opposing Data:

- Boat shape is unimportant, has to be able to handle monsoon waves (K1).

- Used the term ‘old fashioned’ to describe high prow (high bow sheer) boats (P1).

Supporting Photographs:

Photo 4.8. Range of profiles, Mersing.

Photo 4.9. Deck usually follows sheer line which provides deck drainage. Note the misalignment with the dock and the requirement for crew to walk on the sloped surface. Endau.

Photo 4.10. Comparison of sheer lines. Open boat in foreground, Class B fishing boat in middle, modern high speed, steel passenger boat in background. Pulau Ketam.

Theme: ***Bow***

Narrative: The bow design relates to reserve buoyancy. The way in which sheer is carried forward into the bow relates bow and sheer designs. However, the high prow typical of these boats is addressed in the 'sheer' theme while this section provides data on how the bow design affects motion, hold capacity and aesthetics.

Summary: Bow design reduces green water, increases hold capacity and affects aesthetic appeal.

Supporting Data:

- High prow keeps waves out (K3).
- Fuller bow gives more capacity (P1).
- Bow should look beautiful (KB1).
- Heavy stem post (observed).
- Malaysian traditional trawlers have higher prismatic coefficient than Western, specifically Canadian, trawlers. The Malaysian values ranged from 0.616 to 0.780 versus 0.556 for Canada (Zamani 2001). [The larger the prismatic coefficient the fuller the ends of the hull]

Opposing Data:

- Bow does not matter (P3)

Supporting Photographs:

Photo 4.11. Unusual bow design creating large holding capacity with no GRT penalty. Note also the large stem post. Pulau Ketam.

Photo 4.12. Variety of bow designs. Pontian Kecil.

Theme: ***Cross Section***

Narrative: Cross section affects the rolling behavior of a hull as well as hold capacity. The cross section is typically U shaped towards the stern and more V shaped towards the bow. Many boats had fuller, U shaped cross sections forward .

Summary: Varied opinions existed about U versus V shapes. U shape give more capacity but produces more rolling and wave slamming in high sea states.

Supporting Data:

- Chinese in Mersing and Endau prefer Teluk Intan (U shape, west coast) boats, while Malays prefer Terengganu and Penang (V shape, east coast) design (E3).
- V shape is considered ‘older’ because it has less capacity per GRT. Teluk Intan design has changed to make more bluff at bow (E4).
- Block coefficients varied greatly in Malaysian trawlers, ranging from 0.328 to 0.652. This compares with Canadian trawlers which have on average of 0.421. (Zamani 2001). [Block coefficient indicates the shape of the cross section, a high block coefficient indicates the hull is more U shaped than V shaped]

Opposing Data:

Not applicable because comparing U and V shaped cross section; however, T16 opined that Thai and Vietnamese boats roll too much.

Supporting Photographs:

Photo 4.13. V shaped cross section towards bow. Endau.

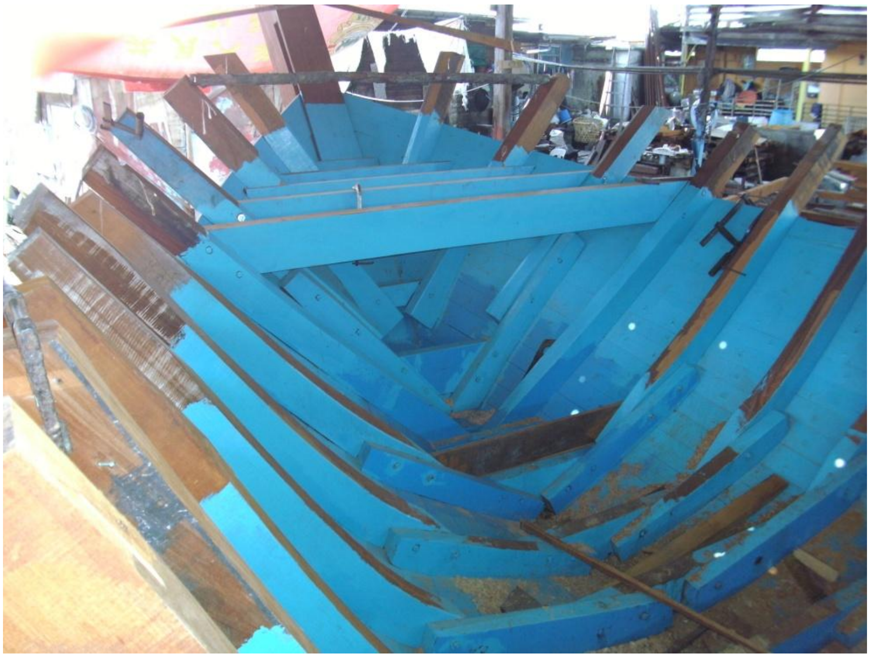

Photo 4.14. V shaped cross section towards bow at PK1 boatyard. Pulau Ketam.

Photo 4.15. Remnant of U shaped hull showing framing construction. Pulau Ketam.

Photo 4.16. U shaped hull section. Tumpat.

Theme: ***Personal Safety and Comfort***

Summary: Personal safety is associated with flotsam and nearby fishermen rather than safety equipment. Comfort accommodations are minimal.

Supporting Data:

- Other fishing boats in sight (observation). See also *Boating Community Interactions* section.
- Would telephone another fisherman if he needed assistance (T13).
- No throwable PFDs, man overboard (MOB) poles or life rafts, emergency position indicating radiobeacons (EPIRB) (observation).
- If they start to roll, I put my foot on top of the gunwale to catch myself [no railing available] (P3).
- Must be "brave" to be a fisherman (S2).
- Engine noise is not a problem, you get used to it (S2).
- No toilet, refrigeration, air conditioning or seating (observation).

Opposing Data:

- Observed two fishing boats with railing at stern.
- Skippers have cellular phones (observation).
- Observed one helm chair that employed an automobile seat.

Supporting Photographs:

Photo 4.17. Typical helm with seat folded up. Pontian Kecil.

Photo 4.18. Atypical helm with a cushioned seat offering a concession to comfort.

Pontian Kecil.

Photo 4.19. Typical helm. Kuala Terengganu.

Theme: ***Aesthetics***

Summary: Boat form did not vary far from the visual stereotype. Ornamentation was limited to the inclusion of a red stem post and banner on Chinese owned boats. Color choice varies by region with green and blue being the most common hull color in the Kuala Terengganu area (aesthetics is described more fully in a later section).

Supporting Data:

- Red posts on Chinese owned boats (observation).
- Color Survey in Kuala Terengganu (observation).
- Owners want beautiful boat but design has not changed his during his career (PK1).
- Have never changed design (K0).

- Owner switches between blue and green in Sedili, jokingly speculates that blue and green may allow boat to sneak up on fish (S3).

Opposing Data:

The color yellow signified honor [referring to a *secuci* not a Class B fishing boat] (KB1). [This informant operated in the Kota Bharu area, which is heavily influenced by Thai culture and their boats were more colorful. Reference the description of secucis later in this Chapter.]

Supporting Photographs:

Photo 4.20. Red used on stem posts of Chinese owned fishing boats in Endau.

Theme: ***Appurtenances***

Summary: Simple machinery onboard. Machinery consisted of an engine and winch often driven with a retrofitted truck axle. Used minimal through hulls.

Supporting Data:

Use discharge hoses over deck instead of through hulls, no toilet, truck axle used to drive winches [this could dictate deckhouse width] (observation).

Opposing Data:

The purse seiners had hoists and many boats had large banks of lights.

Supporting Photographs:

Photo 4.21. Discharge hoses on deck of Class B trawler. Note boots occupying grab rail. Kuala Terengganu.

Photo 4.22. Using winches to haul in net. Kuala Terengganu.

Theme: ***Economic Goals***

Summary: Fishing catch declines during monsoons. Some fishermen resell subsidized fuel for profit. Fishermen were generally not economically prosperous and fishing communities reflected this condition with simple houses and possessions.

Supporting Data:

- Government compares fuel purchases with catch to attempt to minimize illegal reselling (E3).
- Fuel costs are 30 percent of operating costs for trawler (Pauzi et al. 1991 as seen in Zamani p. 50).
- Without subsidized fuel we would go out of business (S3).
- Fish only 1 ¼ hour away, use 400 liters per trip, speed is not an issue (P1).

- Class A and B boats do not go out in bad weather (S1).
- Decline in fishing as a function of monsoon in Omar and Chau 2005. Figure 4.1 shows monsoon increasing the wind speed and wave height of the east coast primarily from November to February. Figure 4.2 plots fish landings versus month. The plot indicates a decline in fish catches during the time of the monsoon on the east coast.
- Government attempting to reduce fishermen poverty rates by offering to relocate and train fishermen for farming. (Hotta and Wang 1985, Bernama 2007).
- Class B boats illegally fish closer than 5 nautical miles, reserved for Class A boats (S1).

Opposing Data:

- One skipper (K2) who drove me around Kuantan owned a late model Mercedes sedan. He was the skipper of a Class C2 boat which fish far offshore.

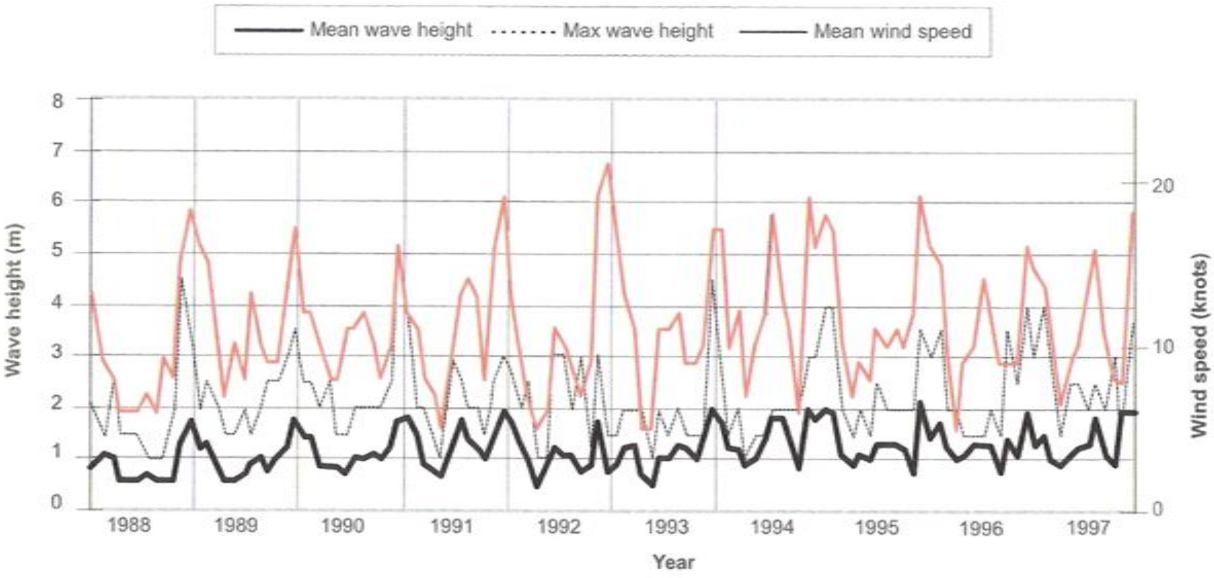

Figure 4.1. Wave and wind amplitude, east coast (4-6 N, 104-106 E), 1988-1997. (Omar and Chau 2005).

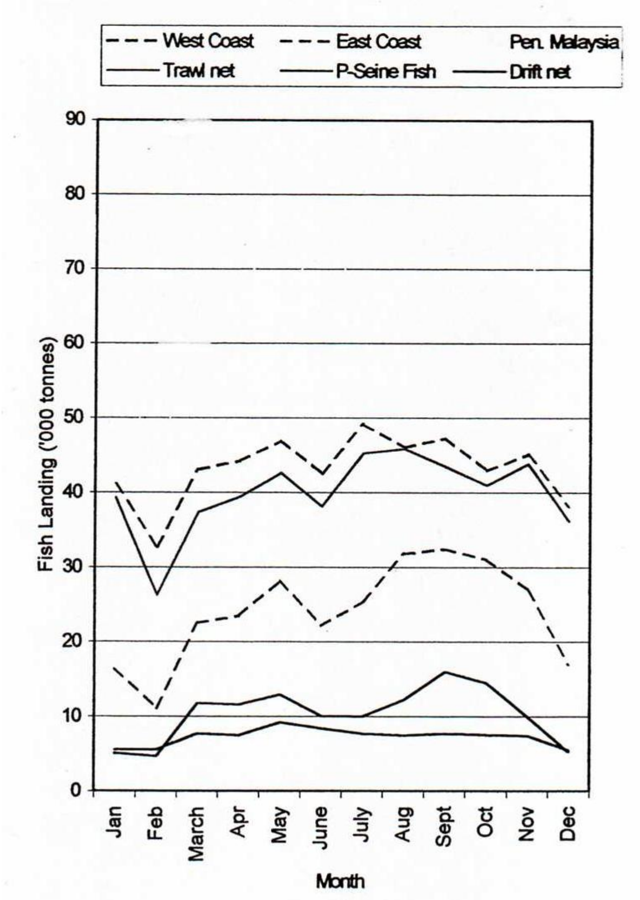

Figure 4.2. Relationship between fish catches and the monsoon on the east coast (top dashed line) Chau 2000.

Theme: ***Boating Community Interactions***

Summary: Some small boats were crewed by skipper's sons but this was not the majority case. Sons assume control of boatbuilding yards. Fishermen would rely upon each other for assistance and information on fishing conditions. No drinking and minimal drug use was observed. The operation of boats and boatyards was egalitarian with skipper and boatyard owner doing menial work.

Supporting Data:

- Father had his sons as crew (T9, T13, T16).

- Boat designer/builder had sons assuming business (T0, T2, PK1)
- Have good chemistry among crew because we need to rely on each other if in trouble (E4).
- Get nervous when no other boats are around in bad weather, do not worry when the weather is good (S2).
- Fishermen talk among themselves to get information on fish catches (S1).
- Two cases of huffing chemicals on boat docks in Kuantan observed and another two at the Kuala Terengganu waterfront, I did not know if they were fishermen however (observed).
- Head boat designer/builder made plank trunnels, which is the lowest level work at a boatyard (T0).
- Skipper operated a winch and helped manually pulled up net, he piloted boat while other napped (T9).

Opposing Data:

- Skipper does not want his sons to become fishermen because it is a tough job and has no securing income (S2).
- Owner of boatbuilding yard will not pass on the yard to anyone, he will close it (KB3).
- On purse seiners [with large crews], crew lock up valuables to prevent theft by other crew (S3).

Supporting Photographs:

Photo 4.23. Hauling in net. Father (second from left, with no shirt) was skipper and owner and two of the crew are his sons. Kuala Terengganu.

Theme: ***Resistance to Change***

Narrative: Resistance to change was one of the most important evaluations required from the ethnographic study. I was able to consider designs by observation but assessing resistance to change was completely dependent on interviewing and observing fishermen and therefore this theme receives a more extensive presentation of data. This theme is also treated later in this Chapter connection with the hull survey and response to new material technology.

Summary: Engines and electronics have been the only significant changes to boat designs.

Supporting Data:

- Owners care only about engine horsepower and capacity (P4).
- No design changes over the years, except electronics. Engine horsepower has increased greatly (K2).
- Rather than redesign, a Tumpat boat under construction had keel bar carved out to accommodate a larger propeller (necessitated by larger engine), which weakened the keel bar (observation).
- A discussion of inefficient design features related to traditional design is provided in Zamani (2000).

Because of the special importance this theme has for design innovation, it is expanded to include more data providing observed examples of slow change or resistance to change.

- Forward propeller, as if propulsion system was inserted into a sailboat keel rather than moving the propeller astern to increase displacement. Instead, boats use an overhung deck, even on a new FRP design (observed in Kuantan). While the light stem and stern are probably helpful in dealing with the short, steep waves they encounter, the narrow bow and high sheer are not necessary on the bigger Class C boats. The failure to more fully depart from a sailing hull is one of the most prominent indicators of resistance to design change.
- High buoyancy aft is produced by canted keelbar.
- Submerged transoms are hydraulically inefficient and especially unattractive in a single propeller displacement hull.

- The use of large, closely spaced, wooden ribs in new FRP construction as seen in Kuantan, which produces an overly rigid design and requires large quantities of wood.
- The FRP design, as observed in Kuantan, attaches the overhung deck to gunwale with through bolts rather than integrating the overhung deck into FRP hull itself.
- The use of bark sealant in Kuala Terengganu boat construction.
- The use of trunnel connections between planks in Kuala Terengganu's shell built construction. Although this produces a strong, monocoque construction, it requires a great deal of labor and probably requires thicker plants to prevent cracking. This technique is not used on the west coast and many of these non-doweled boats are used by Chinese owners on the east coast.
- Heavy fore hatches that rely on weight rather than latches to secure hatches.
- No streamlining of rudder or bilge keels.
- No toilet or galley.
- Uncushioned, wooden helm chairs.
- Engine controls and gauges were not optimally located as they were well below line of sight at the helm and difficult to see.
- Heavy wooden superstructure sun shade (bimini), reduces stability.
- Low bulwarks and no railing.
- Large stem and stern posts, suggesting insufficient understanding of wood engineering. The stem post above the planking is massive and this serves no structural purpose except as a crude bollard.
- Use of crew compartments that follow high sheer resulting in sloping berths that are difficult to sleep on (for one Kuala Terengganu builder). See photograph 5-8.

While beyond the scope of this study, the following observations are illustrative:

- Secucis near Kota Bharu use a highly angled tiller and large rudder that are not ergonomically optimal and imposes an unnecessarily heavy load at the stern. It is unlikely that the large rudder is helpful in maneuvering in following seas.
- When asked what design changes he wanted, a secuci skipper replied the only change they wanted was, "a bigger engine, nothing else." (KB1).
- Use of an unvented propane tank on an aluminum 30 meter police patrol boat.

In contrast to the summary list above, electronics equipment seems to be readily accepted and the design response to government GRT regulations was observed. Specifically, some boats employing a full section forward, especially on the west coast. This design provides a high capacity without a GRT penalty but results in a hydrodynamically inefficient hull. Also, the aft end of boats is fuller than a sailing hull (including the omega stern) apparently to offset the engine's weight and reduce squatting.

Opposing Data:

Fishing boats manufactured from FRP in Kuantan. Malaysia also has the capacity for producing boats from aluminum and steel as seen in Kuala Terengganu.

Supporting Photographs:

Photo 4.24. Melaleuca bark used to seal planks. Kuala Terengganu.

Photo 4.25. Elaborate use of trunnels to produce monocoque hull. Kuala Terengganu.

Photo 4.26. Cracked planking through trunnel holes. Kuala Terengganu.

Design Interconnections

New Materials: fiber reinforced plastic (FRP) boatbuilding

I studied an FRP fishing boat building facility in Kuantan, where I observed the operation and interviewed a boat builder. These boats were built like traditional wooden boats, for example, heavy sawn frames are inserted into the FRP hull. This construction provided and overly rigid structure for FRP and does not take full advantage of FRP material behavior. In addition, the overhung deck remained in this design with the top of the FRP hull being used to support the overhung deck. Even if the overhung deck were desirable, it could have been integrated into the FRP hull rather than being an appendage. This construction approach suggests the tendency to use traditional methods is very strong and the new material was not fully integrated into the design. Interestingly, a toilet is included in the FRP boat where this is not incorporated in the traditional wooden boats. Another new approach used with the FRP boat is to use plywood for the superstructure instead of the sawn timbers used in traditional wooden boats.

Photo 4.27.

Photo 4.28.

Photo 4.29.

Photos 4.25, 4.26, 4.27. FRP construction. Kuantan.

New Technology: outboard engine powered river canoes

Another interesting design interconnection I observed was the protective bar in the river canoes of Sarawak (a northwestern Malaysian region on the island of Borneo) used by the indigenous people (*Iban*) and the Malay fishermen in Cherating. The Iban canoe used on the Lemanak river in Sarawak had a flat bow and an upswept stern. My informants told me this was to protect the expensive outboard motor from damage especially when the boats beached themselves or when other canoes beached next to them. The upswept stern was helpful in placing one's foot against while pulling the start cord. The most common boats in Cherating, on the east coast of peninsular Malaysia, were outboard powered, open boats. This area was unique because a metal arch spanned across the transom. My informants told me this feature was intended to prevent lines and nets from becoming entangled in the outboard's propeller. It seems logical to assume the cross brace on the Iban canoe served the same purpose even though my informants never identified that as its purpose. It appears that a solution to a perceived problem of line entanglement was solved in similar ways by two different populations.

The indigenous people and Malays on the Tembeling river had an upswept bow and flat stern, the opposite of the Iban even though the both used expensive outboard engines. My informants on the Tembeling river commented that the upswept bow allowed them to easily track the movement of the bow from the helm position at the stern. The Iban were unique in that they would have a person at the helm operating the outboard and another person with a pole maneuvering the bow. Additionally, the Iban would have to rotate the outboard engine nearly out of the water to get through very shallow water. They conducted this maneuver often and quiet smoothly.

Although these canoes were beyond the scope of this study, the Malaysian Class B fishing boats derive from small boats design. My review of two styles of canoes was instructive because the designs differed even though both canoes operated in fast moving rivers that would be shallow during the dry season and required high maneuverability and low draft. Moreover, both canoes were propelled by outboard motors and the design response to the advent of outboard engines was interesting to note. For example the Iban of Sarawak developed an attractive and protective stern unlike the peninsular Malaysians, including the indigenous Orang Asli who used Malay built canoes on the Tembeling river. However, the Tembeling canoe did include a more ornate, usually painted, upswept bow that offered an aid in sighting the bow movement.

Photo 4.30. Stern details, Lemanak river canoe. Southern Sarawak

Photo 4.31. Stern arch. Cherating

Photo 4.32. Bow details, Lemanak river canoe. Southern Sarawak

Photo 4.33. Bow details, Trembling river canoe. Taman Negara Pahang

Photo 4.34. Stern details, Trembling river canoe. Taman Negara, Pahang

Identifying Visual Stereotypes

Identifying visual stereotypes, as described in Chapter 3, started early in the field work. Characterization of visual stereotypes was accomplished by photographing the profiles of fishing boats with a digital camera, importing them into a computer aided design (CAD) program, drawing the profile in CAD. Following the CAD rendering of the profiles, the profiles were superimposed to identify the visual stereotype. This procedure established a baseline for the stakeholders' expectations in a boat profile.

The profile data was separated by area of operation, namely the east coast (operating in the South China Sea) and the west coast (operating in the Strait of Malacca). This separation was motivated by the differing sea states of these bodies of water. Moreover, it was consistent with Zamani's geographic study that noted differences in boat design between the two coasts.

This sheer line, bow rake, deckhouse height versus freeboard height, and horizontal length of the deckhouse versus hull length are shown in Figures 5.1 and 5.2. The data is divided geographically between the east coast and west coast. Figure 5.3 includes this same data for an east coast boat that was measured as described in detail in Chapter 3.

Hull Measurement

In Kuala Terengganu I visited five builders/designers. After these visits I found one boat that fit my requirement of a Class B boat that was near completion. The subject boat design included more aft sheer than typical boats and the deckhouse was unusual because the roofline matched the prominent aft sheer. However, this was the best boat available and the sheer line did not affect the underwater form.

The designer/builder of this boatyard allowed my UTM team (consisting of myself and three technicians) to measure the boat hull, even though the procedure could take up to three days. I did not offer the owner, nor did he request, any compensation for our intrusion. I found all the boat designers/builders I visited were pleased at my interest in their work and were fully cooperative.

Because our work was not on deck, I believe we were minimally intrusive upon the operations at the boat yard. The measurements were completed in two days. On the third day we returned to verify some points on the hand-drawn lines drawing. The lines drawings of the measured boat appears in Appendix 6.

Aesthetics

Background

My observations of Malaysian aesthetic traditions derive from visits to museums, galleries, municipal decorations and homes. I also observed the designs of currency, stamps and state sponsored architecture. I visited all the museums related to the maritime world, most notably the Maritime Museum in Malacca and the State Museum in Kuala Terengganu. I noted the decorations used for municipal lighting, bus stands, advertisements and a wide range of industrial products. I also observed the art, decor and styles of homes of fishermen, friends and neighbors. These reviews offer a mixture of government supported images such as appear on currency with those arising organically such as appear on posters, art and advertisement.

Overview of Malaysian Commercial Design

Observing the design features of buildings, vehicles and other commercial designs provided some insight into Malaysian design philosophy. This serendipitous approach to assessing commercial design has weaknesses in that it is unstructured. However, I endeavored to look primarily at those designs which are potentially dangerous; specifically I selected applications related to electricity, fuel, and playgrounds. Designs associated with these applications are tightly regulated in the US and provide good insight into Malaysian design philosophy. I describe cases which were commonly observed and not anomalies, as this would be an unfair and unhelpful portrayal of commercial designs. I concluded that stark utilitarianism drives the Malaysian commercial design philosophy toward industrial products and systems. The design goal, to use the wording of several of my informants, is satisfied when “it works.”

Electrical

- The electrical feeds into buildings were not enclosed. The three phases were brought in with insulated wires uncontained in conduit. These are then tapped off for the electrical feeds to the buildings. No NEMA enclosure or conduit protects the wire; however, the feeds are located high and out of normal reach so this feature provide a measure of safety
- Gates to power transformers are unlocked, allowing anyone to access these dangerous high voltage devices.

- Most outlets in homes had switches at each outlet. This allowed the outlet to be shut off. This is a feature not seen in the US and would allow devices plugged into the outlet to be turned off at the outlet rather than on the device itself.

Photo 4.35. Power entrance to commercial buildings. Skudai.

Photo 4.36. Unsecured electrical substation. Skudai.

Fuel

- The typical cooking range in the homes consists of a two burner stove attached to a propane tank. The tank rested underneath the stove and was attached with a flexible hose. The tank was unsecured and the cabinet unventilated. I saw this arrangement in all the homes I visited. All the boats I observed had this style of cooking system also, including a modern, high speed 30 meter Police patrol boat. This is not allowed in the US for homes or boats because propane is heavier than air and will not dissipate if it leaks in an unventilated enclosure, thereby allowing an accumulation of gas and potentially explosive mixture.

Photo 4.37. Residential propane installation, unsecured and unventilated. Skudai.

Photo 4.38. Commercial propane installation. Propane unsecured and near hot grill. Skudai.

Photo 4.39. Unprotected waterlines in parking lot. No protective bollards to prevent cars from hitting them. Skudai.

Playgrounds

- Many linkages for swings were heavily worn through and corroded.

  Failure of these linkages could drop a swinger and cause personal injury.

- Manholes were left open in playgrounds, a potential trip and fall hazard.

Photo 4.40. Heavily worn linkage for child's swing at public playground. Skudai.

Photo 4.41. Open man hole near playground. Skudai.

Miscellaneous

- Both commercial and residential air conditioning (cooling) usually consists of a ‘ductless mini-split’ system. This device blows very cold air into a room rather than ducting conditioned air uniformly throughout a room. This ductless mini-split design permits easy retrofit installation and the cold, blown air better accounts for the typically high infiltration rates of tropical buildings, which do not normally include the insulation and infiltration barriers of modern, cold weather designs. However this design does not dehumidify and the air becomes cold and humid, often requiring that a sweater be worn.
- Refrigerant lines are often unprotected.
- Piping in parking areas is often unprotected from vehicular damage.
- The Proton car is made in Malaysia and although it consists of modern automotive features it follows common design forms arriving from Japanese and American sedans. There does not appear to be anything uniquely Malay about the form.

Photo. 4.42. *Photo. 4. 43.*

Photo. 4.42 and 4.43. Standard air conditioning condensing unit mounted on high speed passenger boat. Note unprotected refrigerant lines. Pulau Ketam.

Photo 4.44. Unenclosed air conditioning condensing units hung on ceiling of large store. Mersing.

Historical Design Influences

The influences of Sumatra and Java can be seen in Malaysian customs and tradition. Traditional music has the sound of Javanese *gamelan* music as does the style of the Malaysian dance form *dikir barat*. Shadow plays *wayang kulit,* depict the Hindu epics of Mahabharata and Ramayana as are currently shown on Bali (Lukens-Bull 2005). Perhaps the most notable connections are with *batik* and the *keris* knife. Both the wax boundary technique and the naturalistic imagery of the batik craft are shared between the Indonesian islands and Malaysia. The keris (Fig 4.63) is a unique knife design because of its wavy blade. The knife is accompanied by hilt that is usually decorated with floral and plant motifs. The keris is an important icon in both Malaysia and Java. The keris is worn as a symbol of power by the Sultans and was processed at the UTM Convocation I attended as a symbol of the university's authority. The keris is also standard ornamentation for the Malay groom. The keris is depicted on the 1 ringgit coin but I never saw any of these coins in circulation.

The kite (Figs 4.49 and 4.50) is also an esteemed icon and is present on the Malaysian 50 sen coin. The traditional kite is modeled after the human body and has a long, elliptical top section and a smaller oval below, although various shapes arise below the main oval. Like the keris, these kites are typically decorated with plant and floral imagery.

Photo 4.45. Cargo carrier 'Kemajuan T.65' built in 1946, 34.5 m long, 10.4 m beam, 4 m draft. Terengganu State Museum, Kuala Terengganu.

Malaysian Aesthetic Tradition

Batik is an important art form for the Malays and is incorporated into national dress. Malaysian batik often includes flowers and plants. The colors used in national costumes tend to be very vibrant with men wearing yellow, chartreuse and pink. The government encourages people to wear batik on Thursdays and I saw this abided occasionally at UTM by both Malays and Chinese.

Islam is closely tied to Malaysian society and Islamic images avail themselves in Malay homes and state architecture. While the resistance to imagery within Islam is debated, resistance is focused of living beings which may be rooted in the Hadith (Traditions of the Prophet) and Qur'an (Department of Islamic Art 2001). This resistance may affect the stem post designs which are devoid of the dragon images earlier portrayed on boats.

One aesthetic tradition shared by the Malays and Chinese Malaysians is an attraction to calligraphy (Arabic and Chinese respectively). I did not find any other correlations beyond these two; however, natural themes resonate in both these cultures and scenes of nature including water, plants and animals are common in both Malay and Chinese art. This can be seen in traditional Chinese landscape paintings or the work of Latiff Mohidin (b. 1941) an important Malay artist whose painting entitled *pago-pago (1964)* has appeared on a 1 ringgit postage stamps.

*Photo 4.46. Pago-pago on 1 ringgit postage stamp. (*Image source: http://1.bp.blogspot.com/_aMOsxUFmdcI/SLupHivNPHI/AAAAAAAAARA/HBZ6vksArck/s320/Pago-pago.jpg)

Islamic art is an important visual element in many Malay homes. This art tends to have Arabic script from the Koran and the colors tend to be gold on black or silver on a dark green or red. Chinese homes often contain a small red shrine in their yard although some have them inside their homes. Both Malay and Chinese homes have been observed to have a broader array of art than those which are religiously inspired. However, religious art predominated in the Malay homes I visited.

Color

The color green is significant in Islam, perhaps due to the reference in the Koran as being the color worn by those residing in their understanding of an afterlife, or because of the color's connection with nature. Green appears on the flags of many Islamic nations and is used in the decorations inside mosques. White is also an important color in Islam because it represents purity and is worn by many religious leaders. The Islamic Party of Malaysia (PAS), which governs the northeastern states of Kelantan and Terengganu, uses green and white in their representative flag and I noticed their office building south of Kuala Terengganu had a green and white paint scheme.

Red and gold are auspicious colors for the Chinese and relate to good fortune. Many temples are painted red and brides wear red gowns. Gold and yellow are associated with the Chinese emperor and also with wealth.

The background color of the paper currency in Malaysia includes all the primary and tertiary colors except for yellow. The Malaysian flag shows a yellow crescent and star against a blue background and also includes red and white horizontal stripes.

Iconic Images

For consideration in my boat designs, I looked to iconic Malaysian symbols that would minimally alter the visual stereotype. Important iconic images that might appeal to male fishing boat stakeholders are the keris and kite, described previously. Both of these are held in high regard in Malay culture.

These iconic images have been integrated into national symbols; however, they are not intrinsic to the Chinese Malaysian culture where Chinese traditions dominate. These traditions include: ancestor worship, home temples, the Chinese calendar, concern with numerology, and the use of the red banner on boat stem posts and door frames. Phone numbers which are thought to bring good fortune command a higher price than other numbers. I had two phones while in Malaysia and selected standard numbers over the much more expensive lucky numbers. According to my Chinese Malaysian informants, Chinese Malaysians are typically attracted to images as dragons, curved roofs and corridors (to frustrate spirits), the color red, and certain numbers such as 2, 3, 5, 7, 8 and 9.

Malaysian currency was another source for identifying Malaysian iconography. All paper currency contains the national flower (hibiscus) and various graphics. Although the 1 ringgit and 1 sen coin exist, I never saw them in circulation. The 1 ringgit portrays a keris knife, described previously, but was withdrawn in 2005. The 1 sen shows a *rebana uni* drum but is not in use because of the formal policy of rounding to the nearest 5 sen.

The following summarizes prominent images.

Coinage

50 sen: Kite

20 sen: basket (*sirih*)

10 sen: decorative board game called a *congkak*

5 sen: a spinning top (*gasing*)

Paper Currency

The front of all paper currency portrays Tunku Abdul Raham (the first Prime Minister) wearing traditional Malay attire.

The reverse images are as follows:

1 ringgit: kite (*wau bulan*) and mountains (Kinabalu and Mulu)

5 ringgit: Petronas Towers (KLCC) and airport

10 ringgit: train, jet airplane, and ship

50 ringgit: palm oil tree and molecules (older bill, still in circulation, had an offshore platform)

100 ringgit: Proton car plant and engine

Photo 4.47. 1 Malaysian ringgit detail.

Photo 4.48. 50 Malaysian sen coin.

Summary of Malaysian Icons

The most common non-religious patterns were those deriving from nature. Floral and plant patterns are the most common decorative element in batik, jewelry, kites, keris hilts, wood carvings, and roof peaks. Although the icons promulgated by the government through currency and stamps would encourage the Chinese Malaysian to associate themselves with these images, this population is still attracted to traditional Chinese aesthetics and iconography.

The following are a list of commonly occurring Malaysian icons that could be applied to boat design and could be considered external design influences because they do not derive from the stakeholders but from society.

Malay and Chinese:

kites, fig tree, palm fronds, hibiscus flower, Proton car, traditional Malay kite design (*wan jala buidi*), Petronas (KLCC) Tower, however the cross section of the building has an Islamic geometric motif that would resonate more closely with Islamic Malays.

Malay only:

peaked hat, national costume, Arabic calligraphy, Islamic mosques

Chinese only:

color red, Buddha statues, Temples, curved or zig zag structures

Photo 4.49. *Skudai*

Photo 4.50. *Kota Bharu.*

Photos 4.49 and 4.50. *Malaysian kites.*

Boat Aesthetics

The aesthetic tradition in Malaysian fishing boats seems to be rooted in utilitarianism. The hulls are unadorned and the paint schemes are typically a solid color of green, blue, black, red, or yellow with the superstructure color dictated by regulations.

Many boats have a contrasting color along the gunwale upon which is painted the registration number. Many hulls, especially on the Chinese west coast, are unpainted. The Chinese boats consistently included a red banner tied around the stem post. These banners were usually faded to a pink color.

From a material culture perspective, I did not observe a close tie between the fishermen and their boats. The boats were undecorated and lacking personal decorative items such as posters, statues or anything that could be contrived as a talisman. The fishermen's homes were usually equally unadorned. Kuala Terengganu seemed to be the most distressed and Pulau Ketam the most prosperous. Pulau Ketam is located near Kuala Lumpur and they receive weekend tourists who buy seafood, which may support the higher standard of homes.

Photo 4.51. Fishing community. Kuala Terengganu.

Photo 4.52. Fishing community. Kuala Terengganu.

Photo 4.53. Fishing community. Pulau Ketam.

Photo 4.54. Fishing community. Cherating.

Photo 4.55. Fishing community. Note modern buildings in background. Pontian Kecil.

Photo 4.56. Fishing community. Former boat builder repairing a propeller. Pontian Kecil.

Secuci, the exception

Northeastern Malaysia has an anomalous aesthetic and design style among an enclave of *secuci* boats south of Kota Bharu. Most strikingly, they employ vibrant colors and highlights. The secuci is not a Class B fishing boat and lies outside the scope of the study. However they offer insights into boat design history and aesthetics.

Secucis have a narrow beam and are double ended in the tradition of the Western dory. However, these boats have wide, flat stem and stern posts, unlike the square cross section of most traditional boats. These boats are usually crewed by two fishermen and were originally designed as a sailboat; however now they are all motorized.

While the secuci design has long existed in Malaysia (a hundred year old secuci was docked next to the one I traveled in), it is not used as a commercial fishing boat except in the Kota Bharu area. Moreover, in the Kota Bharu area the styling seems to be influenced by Thai aesthetics. While this area is strongly Malay and Islamic (few Chinese live here and the Islamic Party of Malaysia, PAS, governs) it has a strong historical connection with Thailand. This northern portion of Malaysia was part of Thailand until 1909 and was returned to Thailand during the Japanese occupation in World War 2. The return of the northern portion of Malaysia was an act of appreciation by the Japanese for allowing Japan to land troops in Thailand for its invasion of British-held Malaya. During the Japanese occupation, students were compelled to learn both Thai and Japanese and official correspondence was conducted in Thai.

The Thai connection can be seen in the colorful Buddhist wats arise from the landscape in the area around Kota Bharu. These structures are awash in bright, contrasting colors and vibrant imagery. The color scheme of the secuci can also be seen in the wats, which use a full palette with gold and yellow liberally included in the designs. On my one trip in a secuci with two Malay fishermen, I noted the poor ergonomics of the tiller but was very intrigued by the brilliant color, elaborate stem and stern posts that parallel the slender finials found on many of the roofs in the area. The two crewmen were content and satisfied with their small boat. The only change they desired was “a bigger engine.”

Photo 4.57. Uplifted tiller goes over stern post. Kota Bharu.

Photo 4.58. 100 year old secuci. Kota Bharu area.

Photo 4.59. The yellow hull secuci I traveled in next to the 100 year old white hull secuci. Kota Bharu area.

Photo 4.60. Anomalously colorful secucis. Kota Bharu area.

Photo 4.61. Class A fishing boat passing our secuci. Note that like the secucis, this boat is also decorated with flags and bright colors. Kota Bharu area.

Photo 4.62. Sultan's river boat showing ornate stem treatment with the bird modeled after Petala Indera, a legendary Kelantan bird related to the sovereignty of the king. Built during the reign of Sultan Muhammad IV (1899-1920). Melaka.

Photo 4.63. Keris knife with hilt. Melaka.

Identifying aesthetic influences for my boat design, the Malaysian automobile?

In addition to identifying iconic imagery, I endeavored to identify modern aesthetic appeal that might also inform the concept boat design. However, I quickly realized that most consumer products are imported and did not necessarily represent Malay aesthetics sensitivities. In addition, the fishing industry is male dominated and I never saw or heard of a single woman connected with fishing. Therefore, I sought a sample industrial product that might be important to Malaysian males and would reflect Malaysian aesthetics. The image that arose was the Malaysian car, called the Proton. Malaysians take great pride in this automobile that was introduced in 1985. The Proton automobile is available in many styles and colors. The logo included the Islamic crescent (although Proton recently changed it to a stylized tiger head). However, I did not find distinctive design elements as the styling was reminiscent of traditional Japanese sedans.

Color Survey

Because Kuala Terengganu is the center of boatbuilding on the east coast, I conducted a survey to identify the colors that a typical Malaysian in Kuala Terengganu is exposed to in an industrial product much akin to a boat. These are the colors that would be considered common or 'normal.'

Using the automobile and scooter as a baseline industrial product with consumer appeal, I spot sampled automobile and scooter colors in Kuala Terengganu. I observed 119 automobiles and 56 motor scooters driving along a major street during a workday. This survey was not fully representative, probably under representing the youth market. A further caveat is to recognize that a wide range of colors are available from car manufacturers, including Proton, so it is common practice for dealers to stock cars that they can sell quickly and this dynamics was not investigated.

The following presents the survey results with only the top four colors listed:

Table 4.1. Spot Sample of Automobile Colors

Color	*Automobiles (percent)*
Silver	38
Black	16
White	11
Red	11

If dark gray and dark gold colors are included with silver, the percentage rises to 51 percent. Clearly automotive colors tend towards muted natural colors.

Motor scooters are less expensive than automobiles and this dictates their demographic attraction. Scooters are also more efficient at getting through traffic because they can pass between cars. A colleague of mine prefers using his scooter rather than his car because of its efficiency in moving through heavy traffic. In Kuala Terengganu, the traffic is not congested so this should not be as much of a factor as in more populous cities.

Table 4.2. Spot Sample of Motor Scooter Colors

Color	*Scooters (percent)*
Black	38
Blue	27
Red	21
White	11

I also surveyed 48 traditional fishing boats in and around Kuala Terengganu. The hull color breakdown is as follows:

Table 4.3. Survey of Kuala Terengganu Hull Colors

Color	*Hulls (percent)*
Green	33
Blue	27
Red	17
White	15
Black	2
Orange	2
Unpainted	4

This survey indicates that green and blue are the most common hull colors in Kuala Terengganu. Interestingly, in the Kuantan area approximately 180 km south of Kuala Terengganu, few blue hulls were seen, rather green hulls were most common. I observed a 70 percent composition of black hulls in Endau, which was an unusual concentration for the east coast.

In the west coast communities of Palau Ketam and Pontian Kecil I observed approximately 85 percent of boats with black hulls. Blue, white and yellow were rarely seen at these sites. It is also interesting to note that blue and turquoise were the predominant colors among the confiscated Thai boats at the docks in Kuala Terengganu.

Boatbuilding Design Culture

Resistance to change is an important assessment when pursuing a design project. Change is embraced when benefits are obvious and detriments are minimal. Accommodating change can be considered along a continuum from complete rejections to full inclusion. An example of the rapid inclusion of change is the acceptance of engines onboard fishing boats. The alacrity of their acceptance can be illustrated by the story of Norwegian fishermen burning their sails when liberated from the tyranny of the wind. Malaysian boat designers/builders opined that the engine was the most significant change in boat design.

In contrast to engine technology, ostensibly beneficial design features may be rejected completely. This rejection could arise from a philosophical basis, such as promulgated by utilitarianism, or religious beliefs such as with the American Amish. However, it could be related to the complex interactions between builder, repairer, fishermen, training and market economics. The most notable rejection of new technology by traditional boatbuilding communities is shown in material selection, namely their favoring of wood over FRP and metal.

The boat designer/builder informants I interviewed relied entirely on past experience, often inherited through the generations. Boat designer/builder T0 stated explicitly, to become a boat builder one "must follow after another builder" and must be motivated by "interest, not books." Boat designers/builders received very little input from the boat owners who commissioned the boat. This input could consist of as little as boat dimensions, bow angle, color, and engine specifications. The boat designers/builders also received no design feedback from fishing crews.

The boat designers/builders did not use drawings or, for the most part, templates or frames to assist in their construction. The massive stem and stern posts allowed for flexibility because they could accept modifications without cracking or splitting due to their size. Boat designers/builders do not conduct engineering analysis or testing. In addition, the builder is responsible for almost all the design details, little input is provided by the owner. Therefore, they are reluctant to change proven designs and the standard benchmark for a design is that it has worked in the past. Incorporating changes subjects the builder to an undesired risk, one that has little payback. Beyond boat size, the owners have very little input and fishermen have none, perhaps leading to the lack of comfort facilities and safety features. Adapting engines into fishing boats did not lead to corresponding hull design changes or increase in crew comfort.

The design features of the boat suggest resistance to change as outlined in the *Themes* section. For example the reliance on high sheer to prevent green water rather than waterproof decks and freeing ports. My informants characterized the high sheer as either ‘normal’, ‘safe’, or for one informant (a Chinese owner on the Strait of Malacca), ‘old fashioned’. Another informant told me that he had to insist that his boat not have the high forward sheer because he wanted to use it on a river where forward visibility was critical in appraising and navigating the river.

Unusual stern detail

One design detail studied was the omega (ω) shape at stern, observed previously by Zamani 2000. This feature is an upward rise of the bottom of the hull at the keel, giving the cross section an ω shape as opposed to a U shape (see Photo 4.64). I found a large hull under construction in Tumpat with this feature and asked my informant at this boat yard why it was included. The informant initially said this shape improved stability, but as I pressed with further questions (why not just make it flat then, same stability and easier to build?) he said it was to get better water flow to the propeller (which made sense to me). Finally, as I pressed, he said it was the owner’s idea but was suggested by the boatyard. He said it was copied from Kuala Terengganu and had been used for “many, many years.” I found this fascinating because 1) it was not copied from Kuala Terengganu, the assertion that it was may show deference to their designs, 2) he changed his opinion on the purpose and this suggested defensiveness. This defensiveness indicates he may not know why he includes this feature or at least cannot articulate it. I contacted the owner by telephone and email with my questions about this feature and the owner's assistant told me that it was the boat builder not the owner that stipulated this feature.

Photo 4.64. 30 m trawler construction showing omega (ω) stern details. Tumpat.

Photo 4.6. 30 m trawler construction. Tumpat.

Phase II Study

The Phase II study was intended to provide feedback on my conceptual designs. I prepared an outline drawing and clay model of the following designs: 1) Design A, a concept design, 2) Design B, a deck forward, Western design, and 3) the visual stereotype. The intent was to get comparisons between the visual stereotype and the concept design (Design A) as well as a contemporary Western design (Design B). Design B has the significant advantage of a large working deck aft; however, it potentially exposes the forward deckhouse to green water. The terms Design A and Design B are used throughout but these could be replaced with the term 'concept design' and 'contemporary Western design' respectively. The letter designations are a bit clumsy but reinforce the notion that Design B is not the only contemporary Western design. In addition, the terminology prevented me, or others with whom I worked, to inadvertently use the words 'Western' or 'concept' or 'my design' during interviews.

These three designs allowed me to compare the aesthetic attraction towards Design A with that toward the visual stereotype and Design B. The stereotype represents one end of non-mechanistic appeal and Design B represents the other extreme, providing a bracketing of designs. The qualitative assessment of these three designs can be summarized as follows:

	Mechanistic	***Nonmechanistic***
Stereotype	*Medium*	*High*
Design A (Concept)	*Medium*	*High?*
Design B (Western)	*High*	*Low*

The survey instrument was a questionnaire translated into Bahasa Melayu and Mandarin. The questionnaire consisted of five pages (see Appendix 4). The first page was demographic information, the second, third and fourth page had the same eight questions related to aesthetics, safety and functionality. The responses were on a five point Likert scale. At the bottom of each page was an outline drawing of the three designs. The type of boat is coded as follows: a = trawler, b = purse seiner, c = traps, d = nets (besides trawling), e = other type of fishing. The fifth page contained thirteen questions related to specific design issues, which I refer to as the *design feature questionnaire*.

The questionnaire was administered to Group 3 fishermen, that is, they were not affiliated with any of the previous informants. These fishermen were found in Mersing and Endau and fish in the South China Sea. I obtained the assistance of the Department of Fisheries in verbally administering the questionnaire to avoid disenfranchising illiterate fishermen. The administration of the instrument was challenged by my inability to pilot the questionnaire and I was unable to get a large population of Chinese respondents. Many of the respondents did not provide their age but all but one provided their years of experience. The interitem ($1-\sum_d/Max_d$) sigma correlation ranged from 0.75 to 0.83 for the three questions related to aesthetics (Questions 5, 6, and 7). Those questions related to safety (Questions 1, 2, and 3) ranged from 0.65 to 0.67.

The questionnaire in English, Bahasa Melayu and Mandarin as well as the outline drawing and photographs of the clay models are shown in Figures 5.10 and 5.11 respectively. The data from the design evaluation portion of the questionnaire are shown in Table 5.6 while the findings for the design feature questionnaire are given in Table 5.14 in Chapter 5.

CHAPTER 5

PROJECT FINDINGS

I. Thematic Review

Introduction

The following themes were identified and correlated: green water, sea state, sheer, bow, hull cross section, freeing ports, hatches, machinery, personal safety, resistance to change, economic goals (boat resistance/fuel costs), boating community interactions, and aesthetics. Many of these are related to boat design, while others are more directly related to cultural issues. Not all of these themes were fully explored and many unanswered questions still present themselves, especially in the area of economic goals and the social and environmental effects of developing an all weather fishing boat.

The thematic linkages are summarized below using relationship categories of *result, cause,* and *associate* recommended by Miles and Hurberman (1993).

Concerns for green water

- Result of sea state
- Causes sheer design
- Causes hatch design
- Causes freeing port design
- Causes reliance on other fishermen

Concerns about personal safety

- Associated with sea state
- Associated with green water
- Associated with resistance to change

- Associated with economic goals

Resistance to change

- Causes appurtenance selection
- Causes aesthetic appearance

Economic goals

- Causes bow shape design
- Causes appurtenance selection
- Associated with cross section design (more capacity)
- Associated with personal safety (lack of equipment)

Aesthetics

- Result of resistance to change
- Result of boating community interactions

Summary of Thematic Relationships

Freeing Ports

Freeing ports allow deck water to quickly drain overboard and therefore promote boat stability. During my early fieldwork, I noticed that the freeing port area appeared undersized (per the International Maritime Organization, IMO) and this observation led me to inquire as to why this easily produced and basically free design was not produced in accordance with international standards. Because freeing ports are inexpensive to include in hull design, they provided one of the best metrics for gauging the operational environment of the fishing boat.

The Phase I study indicated that the apparent undersizing of freeing ports was related to a typical lack of green water coming onboard. The undersized freeing port design was the first indication that typical Malaysian fishing boats did not encounter substantial green water on their decks in normal operations. Because freeing ports are so easy to include in boat construction, I thought they would be a logical feature to assess in determining deck water concerns. Moreover, the IMO (along with other governing and advisory organizations) has standards for freeing port sizing.

Freeing Port Calculation

I. Kuala Terengganu

For the Kuala Terengganu survey boat, the freeing port size as a function of bulwark area as dictated by IMO a749(18):

$A=K\,l$ (Formula 5.1, IMO, p. 73)

Where,

A = freeing port area (m^2)
l = bulwark length (m)
$K = 0.05$ for $l = 12$m
$K = 0.07$ for $l = 24$m

And,

Reduce A by 0.004 m^2 per meter length of bulwark for each 100 mm less than 900 mm height.

For,

$l = 17$ m
$K = 0.058$ by linear interpolation
Bulwark height = 610 mm

Then,

$$A = 0.058 \times 17 - [(900-610)/100)(0.004)(17)]$$
$$= 0.79\ m^2$$

The calculated freeing port area of the measured vessel in Kuala Terengganu was 0.074 m^2. Therefore the freeing port area is 0.79 - 0.074 = 0.71 m^2 undersized, only 9 percent of the IMO recommended freeing port area.

II. Pontian Kecil

A boat in Pontian Kecil, on the west coast, had a measured freeing port area of 0.018 m^2

From IMO a749(18):as before for:

For,

$l = 14$ m
$K = 0.053$ by linear interpolation
Bulwark height = 300 mm

Then,

$$A = 0.053 \times 14 – [(900\text{-}300)/100)(0.004)(14)]$$
$$= 0.49 \text{ m}^2$$

Therefore the freeing port area is 0.41 - 0.018 = 0.39 m^2 undersized, only 4 percent of the IMO recommended freeing port area. Even with the lower bulwark of the west coast design, which reduces the freeing port area requirement because the lower bulwarks cannot contain as much water, the west coast design has half the amount of freeing port area as a function of the IMO recommended value as does the east coast design.

One of the disadvantages of freeing ports is that fish and small equipment can inadvertently flow overboard through these portals. Freeing ports can become ineffective if plugged by debris or fish (as was reported by one informant). I only observed one boat with protective grates over the freeing ports, although in my observation of trawling many of the fish were small enough to flow through freeing ports. The lack of grates over freeing ports suggests that the fishermen did not allow the fish catch to flow freely or get near the freeing ports. This reinforces the importance of stern sheer for drainage when rinsing fish effectively, which is discussed later in this Chapter.

Another potential disadvantage of freeing ports is encountered in some designs that include a joint where water can seep inside the hull. One boat designer/builder fabricated a channel from PVC piping to minimize this problem, while others used sealant.

The questionnaire data, presented later in this Chapter, indicates that the surveyed fishermen desire more freeing port area in their next boat. This response is indicative of boat designers/builders not responding to fishermen's needs and an undersizing of freeing ports, although there are other indicators of green water rarely coming onboard.

Hatches

Malaysian fishing boats typically have their hatches on the foredeck located toward the centerline. Because of their importance in the safe operation of a boat when encountering green water, regulatory agencies (including IMO) stipulate hatch design and performance requirements. Some exemptions are offered for openings that enter watertight and self draining spaces but this application does not apply to traditional fishing boats.

The Phase I study indicated that the hatch design was related to lack of green water coming onboard. All the hatches observed, without exception, were not watertight. The hatches included coamings that prevent shallow deck water from entering the holds, however they had no latching features or gasketing. The hatches were held in position by the deck coaming and hatch lip. The hatches were heavy so their mass aided in keeping them from coming adrift. No informants reported a hatch failure either by allowing a large amount of water into the holds or collapsing under deck loading, such as produced by the weight of a fisherman, equipment or green water.

The hatches were awkward to use because they need to be pivoted back onto the deck and there were no hand reliefs. Consequently the hatch would crush the fingers of a fisherman if he lost control of the hatch while lowering it onto the deck. In addition, when rotated back, there was no hinge to control the hatch, therefore it was free to slide at the pivot point. These features would make the hatch cover unsafe to operate in steep or irregular waves.

My informants reported no hatch operation problems or injuries, suggesting that the hatches are not operated in high sea states. Furthermore, none of my informants were aware of a hold being filled with seawater due to hatch failure. These statements indicate the coamings are sufficient to keep the holds dry and the boats do not encounter green seas onboard. The lack of green water is further reinforced by observing that many of the engine compartments were not watertight and in most cases were not even enclosed.

Like the hatches, much of the material positioned on deck was not lashed to the deck nor did there appear provisions for securing deck items. This observation suggests that the boat would not be used in a sea state that would upset equipment. Loose equipment on deck is unacceptable because not only can it fall overboard but it can crash into other objects and people.

Transoms

A comparison of measured transom thickness to scantling rules was only conducted on the measure boat at Kuala Terengganu. Because of the single sample, this feature is not included in my analysis but the transom thickness was found to be 46 percent thinner than commonly recommended. This undersizing suggests a lack of concern for loads caused by following seas.

An approximate transom thickness can be calculated using the scantling rules developed by Gerr (2000):

LOA (corrected) = (LOA + LWL)/2, where LOA is greater than 108 % of LWL

= (17.5 m +16.0 m)/2 = 16.75

The dimensionless 'scantling number', Sn is calculated as:

Sn = {[LOA (m)][Beam (m)][Depth of hull (m)]}/28.32
(Formula 5.2, Gerr p.5)

Where, depth of hull is the amidships measure from sheer to top of keel.

Sn = (16.75 m)(5.66 m)(2.64 m)/28.32 =8.83

For Plank Thickness (mm) = 18.79 $Sn^{0.4}$
(Formula 5.3, Gerr p.107)
= $(18.79)(8.83)^{0.4}$ = 44.9 mm

For Planked Up Transom Thickness (mm) = 1.2 x hull topside plank
(Formula 5.4, Gerr, p. 13)

= 1.2 x 44.9 mm = 53.88 mm

Measured upper transom planking thickness = 25 mm

Difference between recommended scantling and measured: 53.88/25 = 2.15 undersized, or 46 % undersized.

Appurtenances (Through Hulls and Railing)

A variety of appurtenances are related to safe and efficient operation of fishing boats. This summary discusses only through hulls and railing.

Through Hulls

In addition to stuffing boxes for the propeller and rudder shafts, typical Malaysian fishing boats had only one through hull, which was used to draw water from under the hull for engine cooling. This quantity of through hulls contrasts with modern fishing boats that commonly include a dozen through hulls above and below the waterline for applications such as speed and depth instrumentation, bilge pump discharge, galley and locker drains. Typically toilet discharge and intake are attached to through hulls but because the Malaysian fishing boats do not include toilets, these through hulls are necessary. Instead of additional through hulls, water was usually discharged with hoses laid on the deck.

This minimalist approach to hull penetrations results in a less expensive boat but encumbers the deck with hoses, which can potentially trip crew overboard. The Phase I study suggests the motivator for this design approach is economics and attitudes about personal safety.

Railing

Railing helps prevent crew from falling overboard but it can be an impediment to gear handling and offloading. I observed only two fishing boats with any form of railing and these were at the stern only. Many boats had significant bulwarks toward the bow that restrain crew but this was not extended amidships and astern.

Hull Cross Section and Overhangs

Economic factors such as taxation based upon hull capacity affect the hull design. Gross register tonnage (GRT) is the measure used for government taxation and this regulatory prescription compels designers to make rectangular hulls and full, square bows to increase the volume without affecting the GRT. This fullness of the hulls is reflected in Zamani's analysis of prismatic and block coefficient (Zamani 1999, 2001), which indicates that the boat stem and stern are fuller than Canadian trawlers and that the cross section shape varies widely.

In the context of cross section and bow design it is interesting to note that the overall hull design probably derives from traditional sailing schooners as indicated by the concentration of loads and weight at the center of the hull. In response to engine weight, the stern is fuller than a traditional schooner, but the fishing boats keep the engine in the center of the hull and often use an overhung transom rather than moving it astern as is done on a modern motorboat. The engine and propeller are installed in a vestigial keel rather than being located further astern. The broad transom also reduces pressure drag in comparison to a double ended hull but is more vulnerable to following seas. However flat, immersed transoms increase drag but this is common in Malaysian trawlers (Zamani 2000) are inefficient because In addition to the larger surface area presented to following seas, the transom thickness, as discussed previously, indicates that the transoms are not intended to encounter wave impacts. The light stem and stern can be helpful in the short wavelength seas encountered in the Malaysian coastal fishing grounds; however, the derivation is closely related to the sailing hulls.

Photo 5.1. Overhung transom, Class C trawler, approximately 20 years old. Mersing.

Photo 5.2. Overhung transom and underwater design with new construction of Class B fishing boat. Kuala Terengganu.

The aesthetic qualities of the bow, used in the broadest sense of the term, could be seen more clearly in Chinese owned boats where the stem post was painted and adorned with a red banner. When asked about the stem post, the most common response is that it was used for mooring. Although the extended stem post can be used for tying ropes when mooring, it is overly large for the task. Moreover, docking impacts normally occur along the sides, not at the stem post. The large stem post is attached to the keel bar and this assembly provides a rigid framework for the hull.

The stem post is much thicker than Western boats using similar attachment techniques between the stem post and planks. The sizing of the stem post suggests that builders are conservative in sizing to ensure they do not crack or fail in service. Although the stem post thickness above the waterline decreases stability to a minor extent, the large post requires a massive section of expensive wood. A high prow produces forward wind resistance that affects boat handling; however, because boats moor in rivers not harbors, their maneuverability is affected by currents more than wind lessening the importance of forward wind resistance. Additionally, most fishing operations (especially trawling) do not create conditions that adversely affect directional stability of the boat.

Photo 5.3. Producing the stem post and keel bar connection. Kuala Terengganu.

Photo 5.4. Shaping stem post and keel bar. Kuala Terengganu.

Photo 5.5. Penetrations into keel bar, sharp corners produce high stress concentrations. Kuala Terengganu.

Photo 5.6. Complex stem post carvings. Pulau Ketam.

The motivation for the size and extension of stem post can only be speculated upon.

The extension of stem and stern posts exist on boats throughout the world from Venetian gondolas to Viking ships to Malaysian *secucis*. In the Malay world, linguistic evidence suggests that extended stem and stern posts are ancient features and independent of other regions within the Malay world (Horridge 1978). The most likely reasons for the continued extension of the stem posts on traditional fishing boats are some combination of the following:

- The thick stem post permits carving and modification during construction without excessive weakening.
- Vestige of bowsprit.
- Vestige of bow figurehead.
- Imparts feeling of strength to the boat. From the helm, the skipper watches the bow more than any other feature of a boat and a strong looking bow can imply the strength of the entire hull. The stem post is part of the keel structure and it is the 'backbone' in the commonly anthropomorphized description of boat components.

Sheer

The sheer line along with proportional relationships between the hull and deckhouse is described by the visual stereotype. The high sheer of traditional Malaysian boats is one of the primary visual features that distinguish them from Western boats. The high sheer of the bow is especially dramatic and this upswept prow offers a dramatic profile.

The sheer line of the boat is an important aesthetic feature; however, in traditional Malaysian fishing this feature is environmentally driven. In the Phase I study, the sheer line reflected concerns with green water falling upon the boat deck. Overhangs at the bow and stern along with an increasing sheer create reserve buoyancy. Increasing sheer at the bow offsets the reduced cross sectional area, consequently the bow is less likely to plough through waves but rather ride over them. Therefore, a high sheer will reduce the propensity for green water on the decks, which can occur offshore as well as in undredged river inlets. Both the rise of sheer at the bow and stern are important because boats encounter steep waves at the estuaries where they dock their boats. Additionally, many inlets are not dredged or marked with navigational buoys requiring both local knowledge and the ability to withstand steep beam seas as the helmsman maneuvers through an inlet.

The high stern sheer is seen in the double ended design of the traditional secuci boat; however, the traditional Class B Malaysian fishing boats usually have only a small amount of stern sheer. In my observation of trawling, the fish rinsing operation is done at the stern and the stern sheer allows the water to run quickly away from the piles of fish. The water then flows overboard through the freeing ports amidships. The combination of the stern sheer and freeing ports was helpful in cleaning and sorting the fish catch. If water did not drain quickly enough, the fish would have sloshed around in the mud slurry and become difficult to handle. If the sheer was too steep, the fish would slide downward amidships and away from the working area. However, this clearing of the deck water on many modern fishing boats is done by arching the deck down towards the gunwales rather than by sheer alone. The Malaysian boats had flat decks athwartship so the deck sheer was the salient indicator of deck drainage rates.

Personal Safety and Comfort

Fishermen accept a very simple life onboard: shared beds sitting above a noisy engine, primitive cooking, and no toilet. Moreover, few safety devices exist such as PFDs, lifeboats, EPIRBs, and railing. The decks are full of nets and other fishing apparatus which makes moving around on the deck difficult and potentially dangerous. The purse seiners in particular are crowded vessels. On the east coast, some informants have observed that fewer young Malays are becoming fishermen but they cite the lack of predictable income rather than comfort or safety issues. On the west coast, no problem with fishermen availability was expressed and the owners would confront malcontent with termination and hiring new fishermen. On the east coast, Thai fishermen can be readily recruited to serve on Malaysian fishing boats. Consequently, labor issues in the form of labor costs, availability or other demands are currently not an issue.

The helm of the fishing boats is also utilitarian, some boats up to 12 meters use long mechanical tillers for steering. I only observed one boat that had an upholstered helm chair, the rest employed simple helm chairs with the back rest perpendicular to the seat and made entirely of wood. The engine gauges were out of the line of sight, probably to minimize wiring runs. The engine controls were located next to the helm chair and often positioned awkwardly in relationship to the wheel.

While the Malaysian fishermen studied did not have available safety apparatus that commonly appear on Western fishing boats their safety concerns were mollified primarily by 1) access to neighboring boats via line of sight signaling, cellular phone and sometimes VHF radio, 2) availability of flotsam (especially wood and the large plastic barrels commonly used for holding supplies such as fresh water), and 3) PFDs. However, the response from the questionnaire indicates crews' desire for additional safety equipment. It is interesting to note that the survey data indicated 71 percent of respondents ‘strongly agreed’ they would want life rafts on their next boat.

Economics

Factors influencing the economics of fishing include the abundance of fish, the weather and government policies. The relationship between fish landings and the higher sea state of the monsoon season is shown in government data relating fish landings to time of year. This data shows a 30 percent decline in landings with the onset of the monsoons due to boats staying in port (Omar and Chau 2005). An additional economic factor is the Malaysian government’s conclusion that too many fishermen are competing for too few resources and their effort to relocate fishermen to other industries (Hotta and Wang 1985, Malaysian National News Agency 2007). The government concluded that many of the boats are inefficient in terms of equipment and personnel and lack of barriers to entry for fishing have overtaxed the coastal fisheries. An additional concern is the environmental impact of trawling. Trawling has been illegal in neighboring Indonesia until the government allowed limited trawling in 2009. Both economic forces and environmental concerns may reduce the opportunities for trawlers in Malaysia.

While the informal sector associated with fishing was not formally studied, I found that it was common for some fishermen to keep some of the catch for themselves. In addition, some crews resold unused subsidized fuel and paid crews with cash.

Other observations include:

- The boat design features are hydrodynamically inefficient, the forward sections do not minimize hull resistance and the boats have high topside weight, suggesting that improvements in fuel efficiency were insufficient to motivate more efficient designs.

- The reselling of subsidized fuel by fishermen may shorten the duration of motoring so as to have more fuel to resell.
- During my trawling observation, the ratio of time spent trawling versus time to arrive at fishing grounds was 4.8. 50 minutes spent traveling to fishing grounds and four hours of trawling. 55 minutes were spent sorting fish and organizing gear for the return trip.
- Boat designers/builders not only have an obligation to their customer but also to their progeny. Therefore, the builder's reputation is vital as many wish to transfer the business to his children (the boat designer/builder in Tumpat was a notable exception).
- The fishing villages observed were comprised of simple wooden homes and fishermen often owned motor scooters but not cars. Because these villages were usually surrounded by modern buildings and homes built of concrete, these observations reflect that fishermen either earn a lower income or possess differing material culture than most Malaysians.

Boating Community Interactions

Design can be influenced by social learning and the interactions within the fishermen's community can affect the appeal of new designs. This group identity is an important consideration when developing a new design. Whether a fisherman is impressed with or scorns a new design is connected with how he thinks his community will respond.

My observations suggested good camaraderie among crews on the docks where fishermen would socialize and loiter. They would watch maintenance men work or simply rest in the shade and converse. I observed no drinking, even among the Chinese and only two occasions of “huffing” aerosolized chemicals, which was done in the open. At sea, fishermen relied on each other for personal safety, providing rescue or towing aid. They also relied upon each other for fishing information and weather conditions. I observed a fisherman warning us about the steepness of the waves as we left an estuary, moving his hand sideways in a sinusoidal fashion to indicate their steepness (a hand signal I could readily understand).

One touching encounter I had was with a father and his two sons (T13, T14 and T15) resting on top of their boat. They were enjoying the cooling night air after a day of fishing. The father was a widow and had two other younger children at home but they seemed tranquil, enjoying the dusk with its pleasant wind. One of the sons (T14) was more stylishly dressed and coiffed than the other. They were not smoking or drinking, just enjoying each other’s company and the reprieve from the heat. This scene was in contrast to the Class C purse seiner behind them. On this boat, the many young crewmen were smoking, laughing, and splashing water on each other. I wondered what the two young men sitting with their father on the Class B boat, about 50 meters apart, thought of them. Did they think they should be acting ‘cool’ and young like those behind them? When I returned around 7:10 PM, they were gone. The call to prayer had just finished and I guessed they went to the mosque for evening prayers.

Photo 5.7. Informants T13, T14, T15 on top of their boat. Impounded Thai fishing boats caught fishing in Malaysian waters are in the background. Kuala Terengganu.

II. Visual Stereotype

The Class B fishing boat visual stereotypes establishes familiar proportions and sheer lines. The following presentation of data derives from the methodology described in Chapter 3. The sheer line is given from the lowest point so there are two equations describing the sheer, one forward from the lowest sheer point and one aft. This description of the curve is keeping with the description of sheer offered in Watson (1998) in which the height of the bow and stern with respect to the lowest point is provided. The curve is best described as a second order polynomial however, the aft sheer is described as a first order to better compare with the Watson standard sheer. The freeboard varies with boat load, which affects the deckhouse height versus freeboard height ration. The data is for unloaded boats; however, one must note the trim, or orientation of the sheer line with respect to the waterline, can vary with loads such as the fill of water and fuel tanks. However, these loads are normally amidships and do not greatly affect trim as much as freeboard.

West Coast (Strait of Malacca)

Average Sheer Line, forward: $y = 0.0243 L^2 - 0.4158 L - .0902$ ($R^2 = 0.9902$)

aft: $y = 0.019 L - 2.11$ ($R^2 = 0.7106$)

or

$y = 0.0046 L^2 - 0.111 L - 1.2371$ ($R^2 = 0.9483$)

Where, L = horizontal length (x axis)

Average Bow Rake = 26.4° from vertical

Deckhouse height versus freeboard height = 2.0

Horizontal length of the deckhouse versus length at waterline = 0.40

Population, n = 7

Sheer line data points plotted:

Table 5.1. West Coast Sheer Line Data

Horizontal	**Vertical**
0.0	0.0
1.0	-0.5
2.0	-0.9
3.0	-1.2
4.0	-1.4
6.0	-1.6
8.0	-1.8
10.0	-1.9
12.0	-1.9
14.0	-1.9
16.0	-1.8
18.0	-1.7

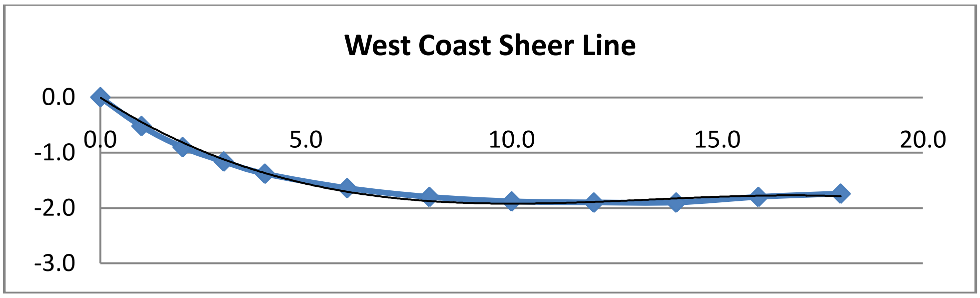

Figure 5.1. West Coast Sheer Line Data

East Coast (South China Sea)

Average Sheer Line, forward: $y = 0.0209\ L^2 - 0.3404\ L - 0.0465$ ($R^2 = 0.9967$)

aft: $y = 0.0391\ L - 1.8847$ ($R^2 = 0.832$)

or,

$y = 0.0078\ L^2 - 0.1689\ L - 0.601$ (R^2=0.9984)

Average Bow Rake = 32.1° from vertical

Deckhouse height versus freeboard height = 2.0

Horizontal length of the deckhouse versus length at waterline = 0.38

Population, n = 7

Sheer line data points plotted:

Table 5.2. West Coast Sheer Line Data

Horizontal	Vertical
0.0	0.0
0.3	-0.2
0.7	-0.3
1.0	-0.4
1.3	-0.5
2.0	-0.7
2.7	-0.8
3.3	-1.0
4.0	-1.1
4.7	-1.2
6.0	-1.3
7.3	-1.4
8.7	-1.5
10.0	-1.5
13.3	-1.5
16.7	-1.3
18.0	-1.1

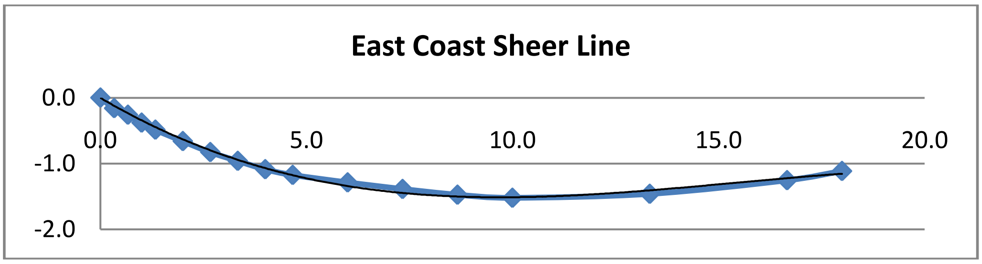

Figure 5.2. East Coast Sheer Line Data

Kuala Terengganu (East Coast) Survey

The boat surveyed in Kuala Terengganu was also analyzed. Because of the rise of sheer at the bow, a high order polynomial provided the best fit, but a 2nd order fit is provided for easier comparison. The surveyed boat was accurately measured as described in the boat survey section however the datum was the keel bar rather than the waterline. Therefore the sheer line, as measured, brings the stern higher than the bow. On the water the stern sinks more than the bow bringing the bow slightly higher than the stern; however, this design does have unusually high sheer abaft the beam.

A half-breadth plan and body plan of the hull based on our survey is shown in Appendix 6. The drawing is dimensioned in a datum manner, which is atypical for a lines plan normally supported by a table of offsets, but datum dimensioning a more generic dimensioning standard. The orthogonal section lines and buttock lines are shown on the drawings and the body plan depicts the stern on the left half of the drawing and the bow on the right half.

Average Sheer Line, forward: $y = 0.0087\ L^2 - 0.1676\ L + 0.0594$ ($R^2 = 0.9634$)

aft: $y = 0.1978\ L - 2.568$ ($R^2 = 0.9285$)

or

$y = 0.021\ L^2 - 0.37\ L + 1.0837$ ($R^2 = 0.9989$)

These sheer line relationships are in their unrotated position, the sheer line is rotated 8° in the superpositioning shown in Figures 5.4 and 5.5 to approximate the floating sheer line.

Sheer line data points plotted:

Table 5.3. Kuala Terengganu Survey Boat Sheer Line Data

Horizontal	**Vertical**
0.0	0.0
1.3	-0.1
2.6	-0.3
3.9	-0.5
5.1	-0.6
6.4	-0.7
7.7	-0.7
9.0	-0.6
10.3	-0.5
11.6	-0.4
12.9	-0.2
14.1	0.1
15.4	0.4
16.7	0.7
18.0	1.3

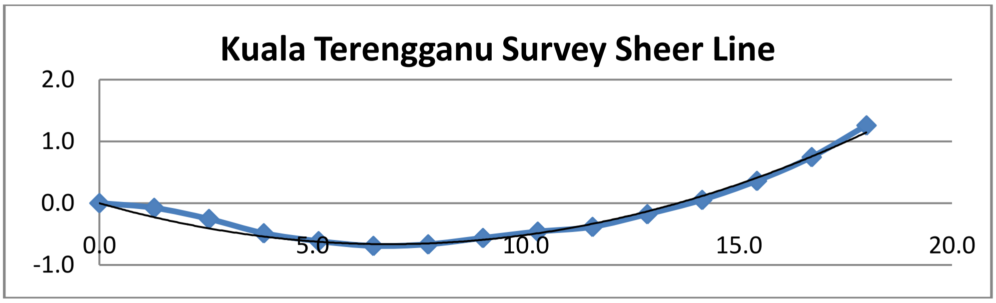

Figure 5.3. Kuala Terengganu Survey Boat Sheer Line Data (unrotated)

Photo 5.8. Floating sample of boat built by the Kuala Terengganu builder whose hull was surveyed. Kuala Terengganu

The three sheer lines are superimposed below to provide a comparison of this feature. The boat surveyed at Kuala Terengganu was rotated 8° to approximate the floating sheer line, that is, the estimated waterline is the datum rather than the keel bar as is shown in Photograph 5.8 above. Two presentations of these sheer lines are provided below. Figure 5.4 shows a common datum at the bow and Figure 5.5 shows a common datum point at the low point of the sheer amidships.

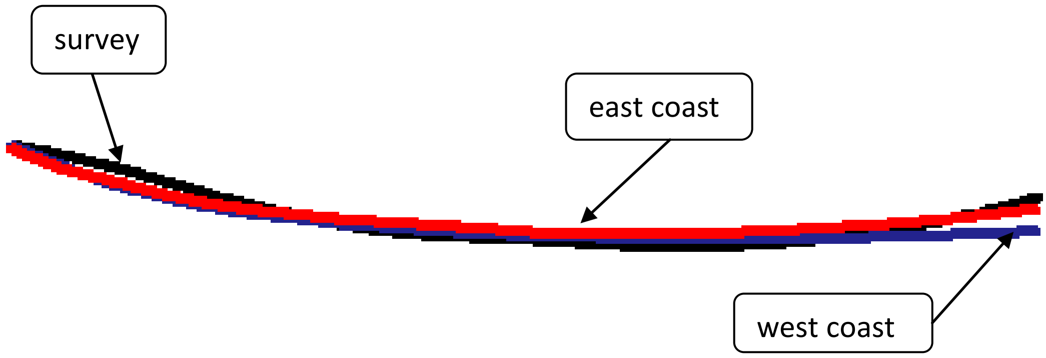

Figure 5.4. Superimposed sheer lines with datum taken at bow. Survey boat is rotated 8° as described in the text.

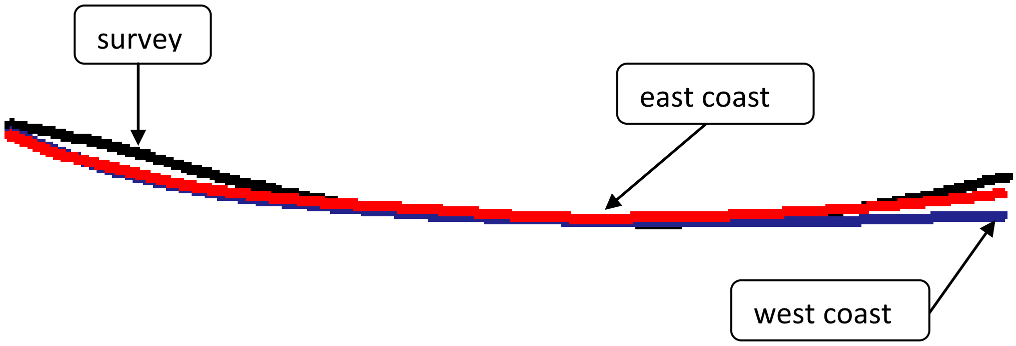

Figure 5.5. Superimposed sheer lines with datum taken at low point amidships. Survey boat is rotated 8° as described in the text.

Summary

The relationship of the deckhouse to the hull is similar for the east and west coast fishing boats. Both the east and west coast profiles have a deckhouse typically two times higher than the freeboard. For the east coast profile, the horizontal length of the deckhouse was approximately 40 percent of the waterline, while the west coast profile was nearly the same at 38 percent. The biggest differences between the profiles lie with the rake angle and sheer line. Compared to the west coast, the east coast profiles had more sheer rise abaft the beam, flatter sheer forward and a bow rake angle difference of almost 6°. The flatter rake of west coast profiles gives them slightly more holding capacity for a given length overall and slightly less reserve buoyancy than an east coast profile. The higher sheer line of the west coast boats gives the bow flare and stem post more prominence than the east coast designs. However, the variances between the east and west coast are fairly small in comparison to the much flatter sheer of a typical Western boat. This data is helpful as a benchmark for my design in that it provides relationships that constitute a visual stereotype. However, the visual stereotype should only act as a general guide to a new design that attempts to maintain a connection to traditional proportions.

The sheers used on Western commercial boats commonly have an aft sheer half of the forward sheer (Watson 1998). Sheer line is very subjective and there is not an agreed upon approach to this design detail. Most modern ships have flat sheers while smaller boats have a rise in the sheer at the bow. However, a traditional Western relationship for sheer of large vessels is (in metric units) is provided by Watson below. No equivalent general equation is available for small boats. Watson's equations give the highest point at the bow and at the stern with respect to the lowest point amidships. A parabolic curve runs between the high point at the bow, the low point amidships and the high point at the stern (which can be seen to be one half the bow height, 0.254 vs. 0.508).

Forward: $y = 0.0166\ L + 0.508$

Aft: $y = 0.00833\ L + 0.254$ (Watson 1998, p. 261)

III. Creative Product Analysis Matrix (CPAM)

The design phase was the most direct expression of professional practice; however, the ethnographic study that preceded my design work was an important step in this design process. The preliminary study of fishing boat stakeholders allowed me to place their design concerns as the foundation for my design work.

Integration of Aesthetic Design Elements

Design can suggest emotions that are important to the fishermen such as safety, strength and even beauty, which I think is illustrated by the overly large stem posts. I was very intrigued by the Malaysian kite (Figs 4.49 and 4.50) because it occurs so frequently in Malaysian society. The shape of the kite was similar to the wing of the indigenous Rajah Brooke’s birdwing butterfly (*Trogonoptera brookiana*). This butterfly is closely associated with Malaysia because it only exists in the Malaysian peninsula, Borneo, and Sumatra.

Photo 5.9. Rajah Brooke’s Birdwing butterfly. Kuala Lumpur.

My concept design (Design A) included elements of the iconic Malaysian kite, with repetition of these lines in the deckhouse. I recognize this design element is not unique and is more Malay than Chinese in its iconographic attraction. However, I think this inclusion is a balance between resistance to change and aesthetic appeal. Design A, the concept design, will derive from the visual stereotype developed from this study, maintaining a vestige of the overhung stern and upswept prow. Design B, with the forward deckhouse, will deviate far from the visual stereotype but will greatly enlarge the working deck and represent a contemporary Western design. See Figures 5.6 and 5.7 for outline drawings and clay models of the designs.

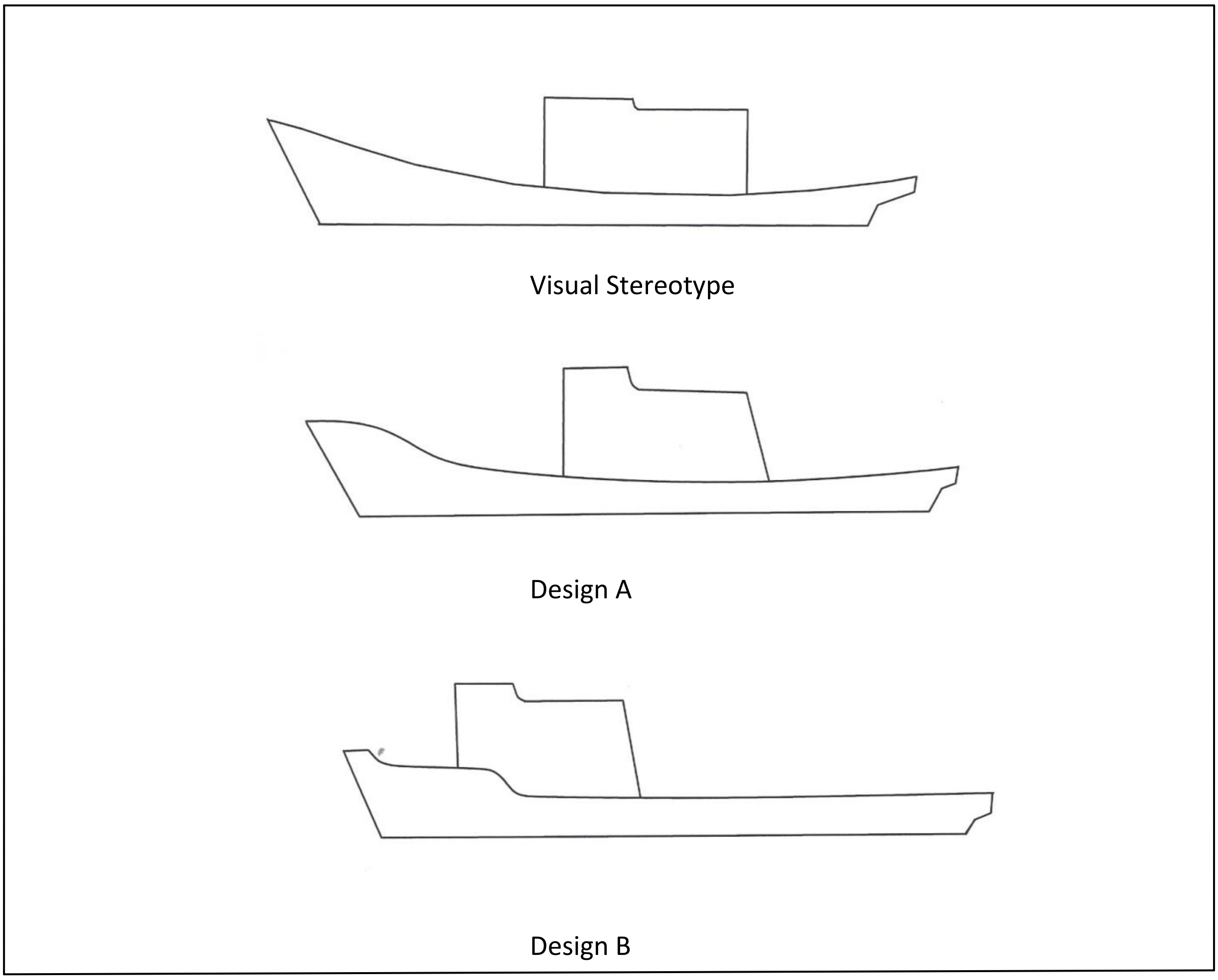

Figure 5.6 Outline drawings of Class B fishing boats used in Group 3 questionnaire.

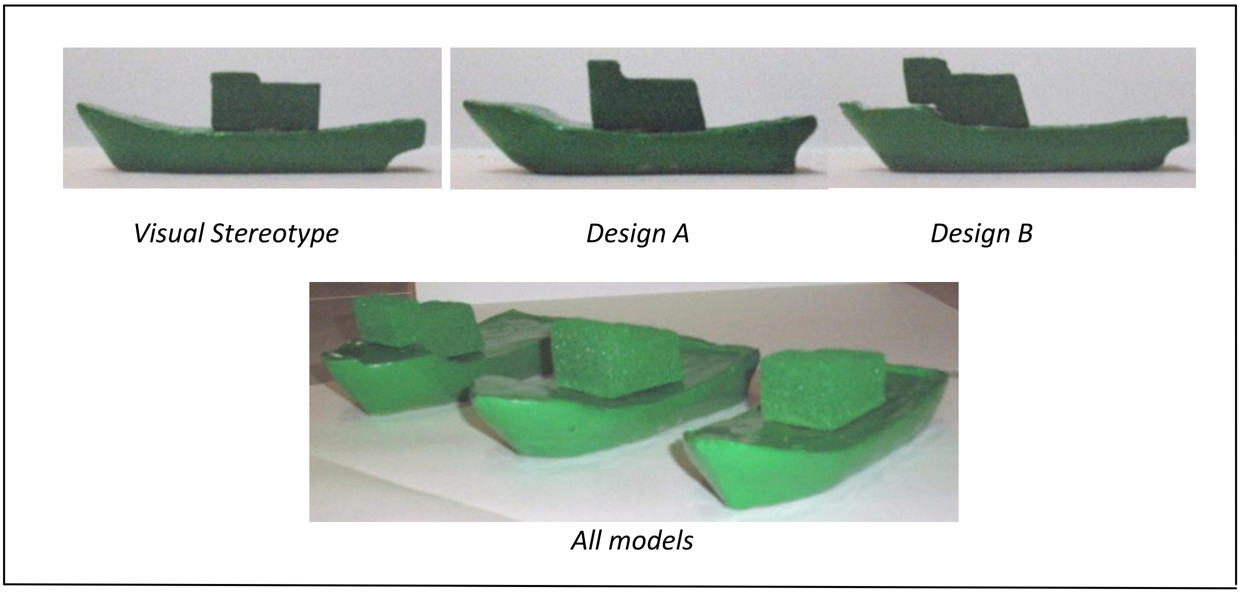

Figure 5.7 Clay models of Class B fishing boats used in Group 3 questionnaire.

Creativity Assessment: Design A

Design A strives to maintain the visual stereotype and includes an iconic element of Malaysian culture, namely the Malaysian kite, into the bow profile. This design maintains the upswept prow that reduces green water on deck and instills confidence in the overall safety. The stem, however, is lowered slightly to reduce windage and weight. In addition, the deckhouse is moved forward to create a larger work area astern.

Design A does not deviate far from the visual profile so some categories, namely germinality and complexity, were rated low. The assertion of low germinal criterion is based upon the unlikliness that this change would encourage others to follow the design lead, especially the bow sheer because the change is largely aesthetic. However the enlargement of the aft work area may incite other builders to follow this approach. The complexity of the design is unchanged and therefore its creativity level is rated as low.

Design A's adherence to the visual profile was intentional and attempts to accommodate resistance to change. While the sheer rise at the bow is intended to visually reinforce resistance to green water coming onboard, the profile is unique so the surprising assessment is rated as medium. The lowering of the stem has practical affects in terms of boat performance, therefore the design's usefulness was rated as medium.

The forward leaning deckhouse compliments bow rake and the canting below the forward windows breaks the vertical line and promote more stable proportions in connection with the freeboard to deckhouse ratio. The deckhouse tumblehome is inclined inward at the top to visually impart a stable proportion and prevent the deckhouse from appearing to be leaning overboard. However this inward sloping angle is necessarily small because side deck space is small.

The organic and understandable criteria were rated as high. This design reflects an important iconic symbol and the fluidity of the ocean waves upon which the boat works.

The design changes are understandable; the shareholders can see the high sheer bow extending back more than the visual stereotype, which will suggest resistance to green water incursions.

See *Conceptual Design Details* in this chapter for details on Design A.

Table 5.4. CPAM Creativity assessment of Design A

Criteria	Creativity Level
Novelty	
Original	Medium
Surprising	Medium
Germinal	Low
Resolution	
Valuable	Medium
Logical	Medium
Useful	Medium
Elaboration and Synthesis	
Organic	High
Elegant	Medium
Complex	Low
Understandable	High
Well-crafted	n/a

Creativity Assessment: Design B

Design B significantly differs from the visual stereotype but reflects a contemporary Western fishing boat. With its forward deckhouse and stepped sheer line, it is unlike any traditional Malaysian fishing boat. The design is rooted in functionality, namely providing the largest possible working deck area. The enlargement of the deck area is accomplished by moving the deckhouse as far forward as possible.

The profile is much different than traditional boats so the surprising assessment is rated as high. It is important to note that traditional Malaysian fishermen would have seen this style of design in the large anchor handling and supply ships that support the Malaysian offshore oil industry. One respondent directly related the Western origins of this profile with steel construction and assumed this boat was made of steel rather than wood. This assumption meant that the boat would not provide flotsam if sunk and therefore he did not like the design. The originality and surprising criteria are based upon Malaysian perceptions and not Western ones. If the CPAM assessment was based on Western perceptions these two categories would be rated as low.

The usefulness is rated as high because the large aft deck provides more area for working nets and processing fish than traditional designs. Moreover, the design keeps the fishermen from negotiating the cluttered side decks around the deckhouse. The germinal criterion is rated as high because the usefulness of the design has the potential to inspire more deckhouses to be placed forward.

The design changes are understandable as the shareholders can see the large deck area as being much different than the visual stereotype. The position of the deckhouse forward on the boat could be either seen as preventing green water from coming onboard or as a potential problem because the traditionally weak deckhouse would be subject to the onslaught of waves. The complexity of the design is unchanged and therefore its creativity level is rated as low.

Table 5.5. CPAM Creativity assessment of Design B

Criteria	Creativity Level
Novelty	
Original	Low
Surprising	High
Germinal	High
Resolution	
Valuable	Medium
Logical	Medium
Useful	High

Elaboration and Synthesis	
Organic	Low
Elegant	Medium
Complex	Low
Understandable	High
Well-crafted	n/a

IV. Phase II Questionnaire Analysis

Phase II is focused on obtaining feedback on the concept design. The survey instrument specifically elicits respondents preferred design, and characterizing those who preferred Design A over the visual stereotype. The aesthetic perspective was the most important question to me because it lends itself better to the presentation of the design in the form of a small model and outline drawing, while an assessment of other issues such as safety and functionality are best made with working prototypes. Phase II surveys Group 3 fishermen, which were comprised of ten Malays and two Chinese Malaysians. The group was very experienced, with a mean 20.3 years of fishing experience, and a non-normal distribution giving a standard deviation of 13 for the Malays. The Chinese respondents had 9 and 35 years of fishing experience. The responses are presented in Table 5.6 with the question numbers referring to the questionnaire presented in Appendix 4. The mean response for all respondents, Malay only and Chinese only is shown in Tables 5.7, 5.8, and 5.9.

Table 5.6 Group 3 informants with questionnaire responses

					Question Number *(see Appendix 4)*								
Informant	**Ethnicity**	**Exp.**	**Age**	**Type**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Hull**
2M6	Malay	20		abd	3	3	2	4	5	3	3	3	***Design B***
					3	3	3	3	4	3	5	5	***Design A***
					3	3	5	5	5	1	1	5	***Stereotype***
2M5	Malay	5		d	3	3	2	4	5	4	3	3	***Design B***
					3	3	3	3	3	3	3	3	***Design A***
					3	3	3	4	3	4	3	3	***Stereotype***
2M3	Malay	30	56	d	1	3	4	5	1	3	2	1	***Design B***
					5	5	5	5	5	4	5	5	***Design A***
					4	5	4	5	5	4	5	5	***Stereotype***
2M2	Malay		23	b	4	1	2	4	5	6	1	1	***Design B***
					3	4	4	4	2	2	1	1	***Design A***
					4	2	4	4	5	3	4	5	***Stereotype***
2M8	Malay	1		b	5	1	1	1	1	5	1	5	***Design B***
					1	5	1	5	1	5		1	***Design A***
					1	1	5	5		1	5	1	***Stereotype***
2M9	Malay	7		b	1	4	2	5	4	1	3	5	***Design B***
					4	4	4	4	5	2	4	1	***Design A***
					4	4	2	4	4	4	4	4	***Stereotype***
2M10	Malay	20			5	1	2	5	5	1	4	3	***Design B***
					5	1	2	5	3	5	2	5	***Design A***
					5	1	2	5	5	5	4	5	***Stereotype***
2E1	Malay	35	52	a	1	1	1	1	1	1	1	1	***Design B***
					5	5	5	5	5	5	5	5	***Design A***
					4	5	5	5	5	5	5	5	***Stereotype***

2E2	Malay	35	51	a	1	2	1	1	1	1	1	1	***Design B***
					5	4	5	5	4	5	5	5	***Design A***
					5	5	4	5	5	5	5	4	***Stereotype***
2E3	Malay	30	52	a	1	2	2	1	1	1	1	1	***Design B***
					5	5	4	5	5	5	5	5	***Design A***
					5	5	5	5	5	5	5	5	***Stereotype***
2E4	Chinese	35	52	a	5	5	5	5	5	1	1	1	***Design B***
					1	1	1	1	1	1	1	1	***Design A***
					5	1	5	1	1	1	1	5	***Stereotype***
2E5	Chinese	9	37		5	5	5	5	5	5	5	5	***Design B***
					1	1	1	1	1	1	1	1	***Design A***
					1	5	5	1	1	5	5	5	***Stereotype***
					1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	

Question Number
(see Appendix 4)

Table 5.7. Mean response to Likert rated assessment questionnaire, all respondents. 1 = strongly disagree, 5 = strongly agree

		Design B	**Design A**	**Stereotype**
1	This boat is safe while handling fishing gear.	2.9	3.4	3.7
2	This boat will allow water onboard in the waves I encounter.	2.6	3.4	3.3
3	This boat will have minimal pitching in the waves I encounter.	2.4	3.2	4.1
4	This boat is easy to dock.	3.4	3.8	4.1
5	The boat hull is beautiful.	3.3	3.3	4.0
6	The boat deckhouse is beautiful.	2.7	3.4	3.6
7	The overall boat design is beautiful.	2.2	3.4	3.9
8	This boat is best suited to my type of fishing.	2.5	3.2	4.3

Table 5.8. Mean response to Likert rated assessment questionnaire, Malay only. 1 = strongly disagree, 5 = strongly agree

		Design B	**Design A**	**Stereotype**
1	This boat is safe while handling fishing gear.	2.5	3.9	3.8
2	This boat will allow water onboard in the waves I encounter.	2.1	3.9	3.4
3	This boat will have minimal pitching in the waves I encounter.	1.9	3.6	3.9
4	This boat is easy to dock.	3.1	4.4	4.7
5	The boat hull is beautiful.	2.9	3.7	4.7
6	The boat deckhouse is beautiful.	2.6	3.9	3.7
7	The overall boat design is beautiful.	2.0	3.9	4.1
8	This boat is best suited to my type of fishing.	2.4	3.6	4.2

Table 5.9. Mean response to Likert rated assessment questionnaire, Chinese only. 1 = strongly disagree, 5 = strongly agree

		Design B	**Design A**	**Stereotype**
1	This boat is safe while handling fishing gear.	5.0	1.0	3.0
2	This boat will allow water onboard in the waves I encounter.	5.0	1.0	3.0
3	This boat will have minimal pitching in the waves I encounter.	5.0	1.0	5.0
4	This boat is easy to dock.	5.0	1.0	1.0
5	The boat hull is beautiful.	5.0	1.0	1.0
6	The boat deckhouse is beautiful.	3.0	1.0	3.0
7	The overall boat design is beautiful.	3.0	1.0	3.0
8	This boat is best suited to my type of fishing.	3.0	1.0	5.0

The data are organized by profile matrices of ordinal data that relate the assessment of Design A and B against the visual stereotype. Questions 7 and 8 were the most emotive responses and I focused on presenting this data. Question 7 asked for a rating of the overall beauty of the boat design and Question 8 asked for a rating of the suitability of the design for the respondents fishing. For overall beauty, one respondent preferred Design A over the visual stereotype, while three respondent's preferred the visual stereotype over Design A. Seven respondents rated Design A and the visual stereotype equally.

One of the concerns with the presentation of Design B was revealed by my informal post survey dialogue with one of the older respondents who told me he thought the boat would be made of metal and was concerned about it sinking. This inference introduced another unintended variable beside the boat's outline and form.

Design B, which intends to bracket the study with a wholly Western design, received the opposite results of Design A. Both the Chinese respondents much preferred Design B over the visual stereotype in most categories. Seven respondents rated Design B as less aesthetically attractive compared to the visual stereotype (this compares to three for Design A). Four respondents rated them equally, while one rated Design B more attractive than the visual stereotype. The same results were reflected in the responses to 'overall suitability'.

The large percentage of informants that rated Design A equal to the stereotype is encouraging in the context of fishermen's propensity to resist change. Although the resistance to change is addressed in the thematic analysis, the resistance to change is further indicated by the large number of respondents who disliked Design B, which strongly departs from the visual stereotype. The more favorable response to Design A compared to Design B suggests a new design that addresses only aesthetics is attractive to certain people. In the Malaysian fishermen community, technical innovation, which is difficult to depict through physical appearance alone, would probably have a broader appeal than the aesthetic component alone because of their strong resistance to change.

These results are summarized in the following and graphs.

Summary of Findings

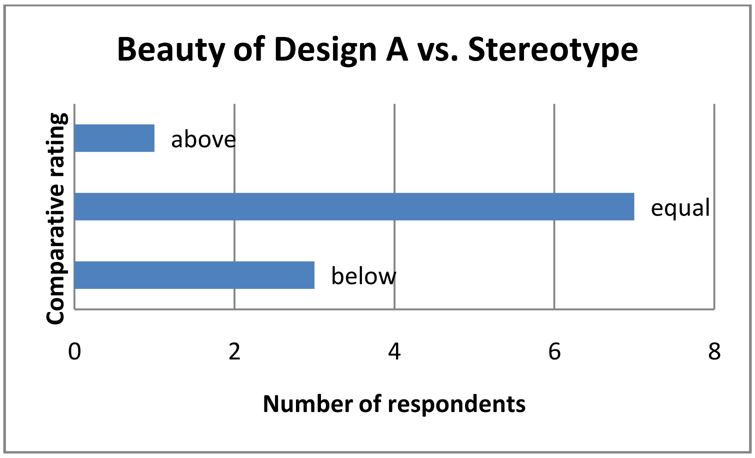

Figure 5.8. Beauty of Design A vs. Stereotype

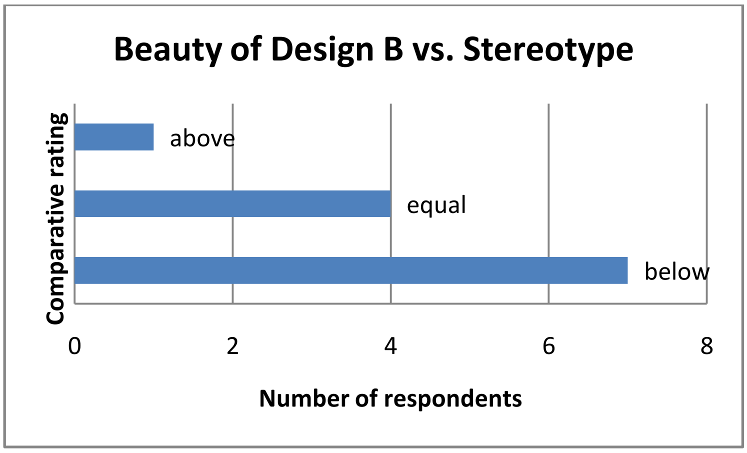

Figure 5.9. Beauty of Design B vs. Stereotype

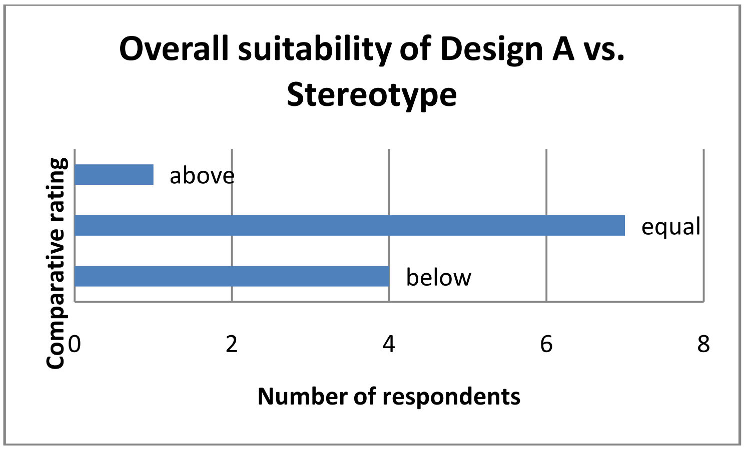

Figure 5.10. Overall Suitability of Design A vs. Stereotype

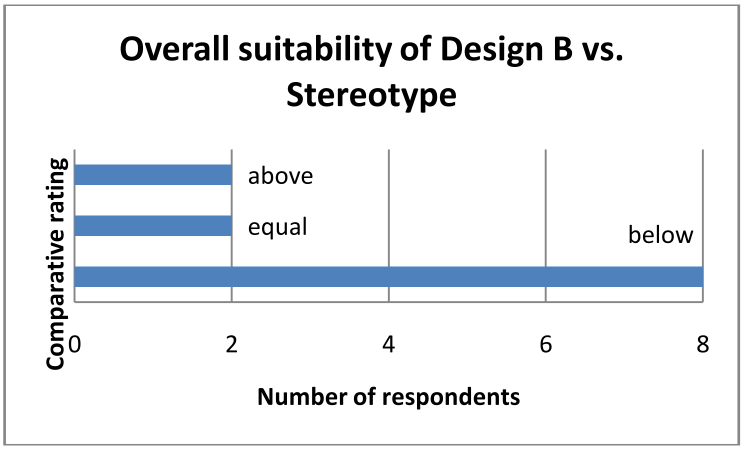

Figure 5.11. Overall Suitability of Design B vs. Stereotype

A description of the respondents versus rating of beauty and overall suitability is provided in Tables 5.9-5.12.

Table 5.10. Summary of Respondents Rating of Beauty for Design A

Design A

Overall beauty rated Design A greater than stereotype, n = 1

Informant	2M6
Experience	20
Age	
Boat	abd
Ethnicity	Malay

Overall beauty rated Design A equal to stereotype, n= 7

Informant	2E2	2M5	2E4	2M3	2M9	2E1	2E3
Experience	35	5	35	30	7	35	30
Age	51		52	56		52	52
Boat	a	d	a	d	b	a	a
Ethnicity	Malay	Malay	Chinese	Malay	Malay	Malay	Malay

Overall beauty rated Design A lower than stereotype, n=3

Informant	2M2	2M10	2E5
Experience	23	20	9
Age			37
Boat	b		
Ethnicity	Malay	Malay	Chinese

Table 5.11. Summary of Respondents Rating of Beauty for Design B

Design B

Overall beauty rated Design B greater than stereotype, n=1

Informant	2M6
Experience	20
Age	
Boat	abd
Ethnicity	Malay

Overall beauty rated Design B equal to stereotype, n=4

Informant	2M5	2M10	2E4	2E5
Experience	5	20	35	9
Age			52	37
Boat	d		a	
Ethnicity	Malay	Malay	Chinese	Chinese

Overall beauty rated Design B lower than stereotype, n=7

Informant	2M3	2M9	2E1	2E2	2E3	2M2	2M8
Experience	30	7	35	35	30	23	1
Age	56		52	51	52		
Boat	d	b	a	a	a	b	b
Ethnicity	Malay	Malay	Malay	Malay	Malay	Malay	Malay

Table 5.12. Summary of Respondents Rating of Overall Suitability for Design A

Design A

Overall best suited rated Design A greater than stereotype, n=1

Informant	2E2
Experience	35
Age	51
Boat	a
Ethnicity	Malay

Overall best suited rated Design A equal to stereotype, n=7

Informant	2M6	2M5	2M3	2E1	2E3	2M8	2M10
Experience	20	5	30	35	30	1	20
Age			56	52	52		
Boat	abd	d	d	a	a	b	
Ethnicity	Malay	Malay	Malay	Malay	Malay	Malay	Malay

Overall best suited rated Design A lower than stereotype, n=4

Informant	2M2	2M9	2E5	2E4
Experience	23	7	9	35
Age			37	52
Boat	b	b		a
Ethnicity	Malay	Malay	Chinese	Chinese

Table 5.13. Summary of Respondents Rating of Overall Suitability for Design B

Design B

Overall best suited rated Design B greater than stereotype, n=2

Informant	2M8	2M9
Experience	1	7
Age		
Boat	b	b
Ethnicity	Malay	Malay

Overall best suited rated Design B equal to stereotype, n=2

Informant	2M5	2E5
Experience	5	9
Age		37
Boat	D	
Ethnicity	Malay	Chinese

Overall best suited rated Design B lower than stereotype, n=8

Informant	2M3	2E4	2E1	2E2	2E3	2M6	2M10	2M2
Experience	30	35	35	35	30	20	20	23
Age	56	52	52	51	52			
Boat	d	a	a	a	a	abd		b
Ethnicity	Malay	Chinese	Malay	Malay	Malay	Malay	Malay	Malay

A bivariate relationship between 'overall beauty rating' and 'fishing experience' could not be established in a statistically relevant manner; however, generally Design B was least attractive to those with the most fishing experience and Designs A and the visual stereotype attractiveness increased with increasing experience.

Informant 2M6 was the only fisherman who rated the overall beauty of Design A greater than the stereotype. 2M6 is Malay with 20 years of experience on a variety of traditional fishing boats. His responses to the design feature questionnaire, in which the appeal of specific design features is investigated, revealed his answers were very neutral. The only exception was his strong desire for a stove onboard, which was the most common response by all fishermen. 2M6 was also unusual in rating the beauty of the stereotype low, with a Likert rating of 1.

Informant 2E2, was the only fisherman to rate the overall usefulness of Design A greater than the stereotype, responded to the design feature questionnaire with seven 'strongly agree' ratings (Questions 1 through 7) while the other responses were neutral.

Design Preferences Questionnaire

Group 3 respondents were asked to complete a Likert scaled questionnaire regarding design preferences. The results are shown in Table 5.14.

Table 5.14. Group 3 fishermen design preferences (Likert scale, numeric values are percentages).

	Question: I would like the next boat I work on to have:	**Strongly Disagree**				**Strongly Agree**
1	more freeing ports	14	0	14	21	50
2	railing on foredeck	15	23	23	15	23
3	higher bulwarks	8		23	23	46
4	onboard freezer for fish holds	7	14	14	0	64
5	second helm station	21	7	7	14	50
6	life raft	0	7	0	14	71
7	hoist	0	0	38	15	46
8	chairs	7	0	28	36	28
9	toilet	8	0	50	25	17
10	fans	23	0	38	23	15
11	air conditioned deckhouse	9	27	36	18	9
12	stove	7	0	7	28	57
13	refrigerator (for crew use)	8	0	42	33	17

As described in Chapter 3, a concern could arise with this data because fishermen may amplify the lack of safety equipment or comfort facilities because they feel this response would be a conduit for change. This is especially a concern because boat designers/builders appear to build that which they have always built along traditional patterns rather than to be adaptive and actively respond to fishermen's input. While auditing safety equipment is not the goal of the project, improving the standard of safety equipment would cost money and this economic reality can influence respondents. The costs for items in this questionnaire would be expected to be carried by the boat owner and they were not part of the Group 3 population.

The design feature questionnaire was subject to social desirability bias as there were 3.9 times as many 'strongly agree' responses as 'strongly disagree' responses. This questionnaire asked for a rating of features that might be considered attractive in that they make the boat safer of more comfortable. However, these design features would nearly always make the boat more expensive and the questionnaire was given to fishermen, not owners. However, the data is helpful in providing relative comparisons between features.

Summary

Due to the small population and large variance of the linear fit, statistical inferences are weak. However qualitative data can be a robust indicator of trends, patterns or attitudes in a group. As such, more interesting than statistical results are the characterizations of the fishermen who rated Design A (concept design) or Design B (contemporary Western design) better than or equal to the stereotype. The quantitative data that could parse the respondents into subgroups for comparison are age, experience, ethnicity, and type of boat. Nothing conclusive can be derived from this data except to note that the aesthetic appeal of a new design is an individual matter deeply rooted in experience and cultural context and does not lend itself to simple statistical relationships.

The results for aesthetic appeal are encouraging, with eight respondents out of eleven rating the concept design equal to or better than the stereotype versus three who rated it lower. If the two Chinese respondents are excluded, this ratio becomes seven Malays rating the concept design equal to or better, two Malays rating it lower. A new design that is equal to the stereotype in a culture with strong resistance to change can be considered successful. This is especially apparent when contrasted with the contemporary Western design, which was much less favorably compared to the stereotype. The Western design had only five respondents out of twelve rating it equal to or better than the stereotype and seven who rated it lower. If the two Chinese respondents are excluded, this ratio becomes three Malays rating the Western design equal to or better, seven Malays rating it lower. This data result suggests that the concept design is more consistent with traditional fishermen's aesthetic sensitivities. However, it is a much more subtle departure from the stereotype than is the Western design. The relative success of the concept design over the contemporary Western design illustrates how the qualitative can inform the quantitative design at the concept stage.

The 'overall suitability' question solicited a response based upon drawings and clay models and may have been difficult to evaluate without a working prototype. This question gave eight out of twelve respondents rating the concept design greater than or equal to the stereotype, while four rated the concept design below the stereotype. This ratio was eight rating the concept design equal to or better, two rating it lower if the two Chinese respondents are excluded. This result contrasts with the Western design, which produced only four out of twelve respondents rating the Western design greater than or equal to the stereotype, while eight rated the Western design below the stereotype. If the two Chinese respondents are excluded, this ratio becomes three rating the Western design equal to or better, seven rating it lower.

Bias and validity are described in Chapter 3 and this project's most vulnerable data was the social desirability bias infused into the design features questionnaire. Sampling bias was minimized by using a wide range of sites, especially on the east coast. In addition, the sampling was done during the non-monsoon season so that the boats and fishermen I encountered at the docks were not disproportionally those who would tend to stay ashore in high sea states. Acquiescence bias was minimized by categorizing responses in relationship to the visual stereotype rather than comparing mean Likert scale ratings.

V. Conceptual Design

Principal Design Motivators

From my Phase I study, I conclude that the current design of the typical Class B (and Class C) traditional fishing boat is motivated by its historical connection with the sailing schooner. This connection explains the light bow and stern section and the forward propeller. The full aft section appears to be in response to the greater weight of the engine; however, the engine could be considered to be located in the keel of a sail boat with the propeller located behind the keel rather than at the stern of the boat, which is typical in modern displacement hull designs. The light bow and stern may be helpful in the short seas these boats encounter, but it more logically is connected with the sailing hull. Boat designers/builders tend to resist change due to their inability to test design changes and a reluctance to accept design risk because of the dependence they and their progeny have upon a successful boatbuilding reputation. Without powerful economic forces to compel them to make changes, the designers will tend to adhere to their schooner-derived hulls.

Another principle motivator for the traditional design is the concern for taking green water over the bow. This concern explains the high bow which acts to keep seawater off the deck. Water is very heavy and the vessel design must allow the water to quickly drain off the deck and stay out of holds, therefore drainage provision and hatch design are often regulated. Traditional boat designs are vulnerable to green water on the deck because 1) the scuppers or freeing ports are small and have been known to get plugged by fish, 2) the large fore hatches are not waterproof, they are held in position by their weight and edges which align with the deck hatch coaming, and 3) lack of powerful bilge pumps. The response to this concern by the stakeholders is to include a high bow in the design.

Local sea conditions also influence these design motivators. Malaysia does not have natural harbors so fishermen use the river estuaries for safe mooring. These river inlets are very shallow therefore steep waves are produced as the water shallows near the estuary. Moreover, the estuaries have sandbars which often compel the boat to enter rivers through a circuitous route that exposes the quarters to steep waves. Some informants told me that Class B and smaller boats have capsized at these inlets as they are especially vulnerable to waves coming from astern. These dangerous sea conditions also may compel the designer to keep the bow and stern light and buoyant as well as inclusion of high sheer to keep the green water out of the boat. The high sheer designs seem to have followed into larger Class C boats that are not as dependent on this feature to the same extent as are small boats.

A circuitous relationship occurs between boat design and fishing activity. The boats investigated in this study are poorly suited for operation in high sea states and the crew does not demand the boats have appropriate design features for this type of service. Consequently, fishermen do not trust their boats in high sea states and fishing catches correspondingly decrease during the monsoon. This dynamic creates a network of intertwined issues, namely the safety concerns of fishermen, seaworthiness of boats, fish catches, fishermen's economic motivations, and leisure time.

Changes to Malaysian fishing boat design need to recognize that perceptions about safety at sea are rooted in traditional dependences on other fishermen and flotsam, not technology. Malaysians demand utility, not beauty in their boats. Providing a design with batik decoration and no improvement in technology would be insulting and directly contrary to the utilitarian focus of the stakeholders. A new design must provide technical advancement that is obvious and not purely cosmetic. This conclusion applies most strongly to the Chinese (who preferred the deck forward Design B) and less so to the fishermen in the Kota Bharu area (who painted their boats in bright colors).

The most powerful force affecting design change will be economic, including the sustainability of chengal wood, health of the fisheries, and government regulations affecting health and safety. While economic forces may diminish the importance of traditional boat building, the large population of these rot resistant boats will likely serve the fishing industry for decades.

Aesthetics

The aesthetic approach for the design is described in detail in the CPAM analysis. My design approach was to minimize deviation from the visual stereotype but to layer upon it a connection with the Malaysian iconic kite, visual indication of resistance to green water and subtle harmonizing of sheer line with deckhouse. The resistance to Design B (contemporary Western design) indicates that the mechanistic appeal of a large working deck was overcome by other concerns. The aesthetic approach to conceptual design proffered in this project can be diagramed as follows:

Malaysian icons →
Stark utilitarianism → Resistance to change → Subtle aesthetics change
Visual stereotype →

Color

Sunlight tends to fade colors and this is most noticeable with red which will wash out to a pink. The fading of light colors is hardly noticeable while dark colors such as blue and green fade to light blue and green. Decks are normally light colored due to the lower solar absorptivity and subsequently lower temperatures of these hues.

Colors have heightened impact when related to religious or cultural identity, for example red is significant in Chinese culture so the stem post should be painted red when desired. Green is one of the colors that has special significance in Islam and was the most common hull color observed in Kuala Terengganu.

Colors are often used to outline features and are traditionally used at the gunwale and as a boot stripe at the waterline. Breaking up the hull color with accent stripes tends to make the freeboard appear smaller, which can help give the boat a stable proportion. Alternatively, freeboard can be enhanced by large, unbroken areas of color. This field of solid color tends to make the freeboard look larger with less exposure to green water and more ship-like than yacht-like.

The colors shown in the concept boat in Appendix 11 are illustrative of various color schemes. All of the colored drawings include the green Terengganu deckhouse color.

Concept Design

The concept design is guided by the visual stereotype and follows the outline of Design A. Some of the styling considerations for Design A are provided in the CPAM analysis in this chapter. The following narrative provides details of the proposed embodiment of Design A.

The specifics of the hull form needs to be related to desired operating speed and optimized with tank testing, which is the best approach when designing purpose built boats. The concept boat design is intended to accommodate changing regulations, technology and application. Therefore, the relationships between block and prismatic coefficients to operating speed have not been articulated. The design recognizes the physical environment with which the boat must contend includes: wind, waves, rain, lightening, salt water, bird droppings, net loads, and docking impacts. Additionally, the crews' safety and comfort are also addressed in this design.

Conceptual Design Specifications

LOA:	14.3 m
LWL:	12.3 m
BWL:	4.5 m
Draft:	1.6 m
Depth Moulded:	2.1 m
Displacement:	29 MT
Cp:	0.63

Hull and Deck

The hull design derives from standard naval architectural/engineering approaches (Taylor and Tang 2006, Aydin and Salci 2007, Watson 1998). In addition, guidance of proportions was developed from the identification of optimal values for prismatic coefficient (Cp), length to beam ratio (L/B), beam to draft ratio (B/T) and length to displacement ratio ($L/\nabla^{1/3}$) from Zamani's (2000) study.

The form of the concept design above the waterline is the same for both the South China Sea operation on the east coast and the Strait of Malacca operation on the west coast. However, the hull form presented in the lines plan shown in Appendix 11 is most appropriate for the South China Sea. It has a full bow and a low block coefficient to provide more comfortable motion and decreases the GRT to keep the boat in the Class B category. The deckhouse is moved forward compared to the visual stereotype to increase working deck space. However the fuller bow allows the same volumetric storage capacity under the foredeck. The stern is flattened along the lines of a semi-displacement to allow for higher speed. Bilge keels are also included to reduce roll. For the Strait of Malacca a higher block coefficient would be preferred because the water is calmer. The horsepower, gear and propeller requirements are dictated by the type of fishing, although it is important to recognize the efficiency of a hull is a function of the speed to length ratio and prismatic coefficient. All underwater appendages are streamlined and cathodic protection for metal components is provided. The hull and deckhouse could be made in the traditional form with wood or from FRP, aluminum or steel.

This design is at the upper limit of the volumetrically based GRT rating limit of Class B operations. This larger size was selected because bigger fishing boats are generally more economically efficient (Viswanathan,et al. 2000) and the government is promoting improved fishing efficiency. The Malaysian Department of Fisheries is using their licensing process to encourage the operation of fishing boats of 40 GRT or greater (Viswanathan,et al. 2000). This design can be easily configured to operate above or below 40 GRT and therefore provide flexibility in response to licensing requirements.

Because GRT is based on volume, a long, more efficient and stable length to beam ratio (L/B) was used (Webster 2006). The design has a prismatic coefficient (Cp) of 0.63, length to beam ratio (L/B) of 3.2, beam to draft ratio (B/T) of 2.9, length to displacement ratio ($L/\nabla^{1/3}$) of 4.7. Zamani's (2000) data is based on Class C fishing boats; therefore, the length to beam ratio for the smaller Class B concept boat would normally be lower. However, I have used a more stable and efficient value, which is 2.6 percent above the mean value of Malaysian Class C fishing boats.

The bulwarks include freeing ports sized per IMO to lessen the stability and flooding threats produced by green water. The deck is cambered to aid in drainage and includes stainless steel chocks, two at bow, two at stern, four amidships (behind freeing ports), and a forward bollard. Railing encircles the deck except at the stern, although this railing could be included for non-trawling applications. Railing gates permit easier offloading; however, the traditional bulwark is maintained. A rub rail is also included. Hard points for attaching jacklines, used to clip safety harness lanyards, are provided on the foredeck.

Fish holds are refrigerated and insulated with a seven ton capacity. Refrigerant leak detection is included as refrigerants are asphyxiates and are potentially dangerous to crews. Fish holds will be located in their traditional position on the foredeck, which allows for the current practice of offloading fish from the foredeck and keeps the deckhouse away from any green water coming over the bow. The forward holds keep the deckhouse in the traditional central location and this provides a more gentle seaway motion at the helm. However when the holds are empty, the trim is affected, therefore one of the fuel tanks is located forward so trim can be adjusted by tank selection. Water and fuel tanks are located below deck to increase stability. Fuel tankage is comprised of two tanks with one centerline day tank. Although desirable, creating watertight sections of the hull or deckhouse are not normally attainable by traditional wood construction.

Sanitary waste storage is not included in this design but should be included in the future. Bilge alarm and two electric and one manual bilge pumps are also included. All discharge lines are routed via through-hulls to reduce side deck trip hazards.

All hatches are watertight. Storage hatches on the foredeck are currently not watertight and rely on the weight of the hatch to keep them in place. Sealed, watertight hatches are lighter and improve the temporary buoyancy of the bow.

Deckhouse

The deckhouse is divided into a forward pilothouse module and an after deckhouse. The pilothouse module contains the helm, toilet, dry exhaust routing (or watertight locker). The deckhouse contains the crew compartment. This design reduces the weight of the deckhouse primarily by using an aluminum pilothouse module and a fabric sunshield abaft the deckhouse.

The forward leaning deckhouse mirrors the bow rake and the canting below the forward windows breaks the vertical line of the deckhouse. This shortening affect suggests more stable proportions in connection with the freeboard to deckhouse ratio. This forward leaning design also gives more area around the helm as well as shading. Tumblehome in the deckhouse also promotes visual stability as vertical surfaces will make the wheelhouse appear to be leaning outward. The tumblehome angle is very small because it confiscates vital side deck area.

The after section of the deckhouse has a retractable aft sunscreen. This feature reduces topside weight for stability and has the added advantage of being removable to clear up overhead deck space. While many concepts were considered, such as three section convertibles, swinging and fan shaped awning, the cantilevered system with a rollable fabric is the preferred embodiment. Because of wave action and rain, this design must be very rigid so longitudinal and transverse frames are included in the awning to keep it stable and reduce noise from wind and wave action. The cantilevered design is preferred because it will remove obstacles in the working area of the deck. In addition, all materials can be locally sourced because it is comprised simply of two coaxial poles, several cross brace poles and fabric.

Traditionally, the crew sleeping/resting area is comprised of a large flat communal area rather than individual berths. The deckhouse layout includes berths that fold back against the wall as a chair and settee but these can easily be configured for multiple uses. Moreover, nets can be stored in the deckhouse during high sea states. Windows in the deckhouse and doors in the pilothouse are normally left open to promote ventilation; however, they can be closed by sliding along rails to prevent water from entering during rain or high sea states. The deckhouse also has a sink with stove attached as well as boot and glove hangers. The deckhouse communicates with the pilothouse module through a crawlway on the starboard side. The engine is below the deckhouse with an access panel on both side decks. The engine room is contained in sound absorbing materials to lessen the onboard noise.

Pilothouse Module

Ideally the forward part of the deckhouse including the helm and head would be prefabricated. This section is more complex than the remainder of the deckhouse because it includes engine controls, electrical, plumbing, doors and windows. The engine controls include throttle/transmission and instrumentation for water temperature, oil pressure, RPM, hour meter, voltage, bilge alarm and refrigerant alarm. The preferred material for this portion of the deckhouse would be aluminum to reduce topside weight. Cored FRP could also be used but aluminum will be easier to modify without danger of allowing the core to become saturated due to poor sealing.

A standard helm chair is provided in which the outer edge of the chair is flush with a seating area that arcs across the pilothouse module. This arced seating allows other crew to sit aside the helm. The area could also be customized to hold charts or large equipment. The chair is removable to allow the arched seating area to become a sleeping berth. The chair is a bolster type in which the seat flips up (or down) and allows the helmsman to stand between the arm rests. The ability to stand up at the helm is important not only to improve visibility but to lessen the stress of boat motion as the legs are better able to handle this motion. The chair and longitudinal dimensions of the pilothouse module are minimized to provide maximum room for working decks and the remainder of the deckhouse however sufficient room is provided for operation while standing.

A reinforced arch and hardened mounting pod at the back of the pilothouse module permits the mounting of lights, hoists or other equipment. The pod could be attached anywhere along the reinforced arch and would be offset if the engine exhaust is routed through the center of the pilothouse module. Also contained in the module are a marine toilet and the engine exhaust through an exhaust casing (or a watertight locker if engine exhaust is routed out the side of the hull). A life raft is mounted above the module along with navigation lights, spot lights, horn and radio antennae. The antenna mast is grounded to a bronze ground plate below the waterline.

Business Considerations

Very few traditional boats are built each year and outside intrusion into the design is unlikely because the builder is beholden to the owner and cannot risk experimentation. Introducing a third party design feature presents the risk of failure to the builder and its impact on his family's prosperity as well as an affront to his competence and the value of his traditional knowledge. The 'not invented here' phenomenon should also arise due to fundamental sociologically driven identity concerns of traditional boat designers/builders.

The retrofit market would have better potential for innovation, such as replacing deckhouses with new aluminum or FRP structures as described in this project. Retrofitting could also introduce other high impact changes such as waterproof hatches and refrigerated holds. Traditionally built hulls and decks could employ steel or FRP, including moldable polymeric composites, for some of the structural members such as the keel bar and stem post to reduce consumption of chengal. Alternatively, more sustainable woods could be used and covered with FRP to improve watertightness, weathering and resistance to marine growth. These approaches would allow boat designers/builders to maintain their traditional approaches except for replacement of their designs for deckhouses, hatches and holds.

Another possible conduit for change is with speculatively build boats, produced by either private enterprise or the Malaysian, that would prove themselves in the market. An innovative design that is speculatively built would require some builder or government supported guarantee of their longevity, fuel economy and reliability.

VI. Case Study for Students of Industrial Design

A case study compels a student to use critical thinking skills in analyzing a real world problem. A case presents a situation and the student is required to investigate and develop a summary of the situation, the central problem or issue, supporting facts and assumptions, potential approaches and solutions, and recommended approach and solution. An outcome of this project is the development of an industrial design case study and a possible solution. The case study has been developed for students of industrial design and proffers the problem presented in this project, namely: design a new boat for traditional Malaysian fishermen.

The case study would be approached by investigating the physical environment, social environment and cultural context. The physical environment investigation would consider, for example, the weather and waves, the sea conditions at harboring estuaries, the equipment and accommodation requirements for the crew, and the equipment required to harvest fish. The social environment would investigate revealing issues affecting the social obligations of the fishermen and the dynamics of their communities. The study of cultural context would compel students to investigate the influences of culture on the fishermen and their boats. This investigation would include study of the material culture, religion, and history connected with fishermen. The students would identify methods by which they could gain insights into each of these approaches. A potential solution to the case study is to approach the design with the mixed methods described in this project, rather than purely through engineering or personal design and aesthetic approaches. The case study for students of industrial design is provided in Appendix 10.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Connection with Previous Learning

This project is the culmination of the DProf modules, which parallel Kolb's description of the experiential learning cycle of concrete experience, reflective observation, abstract conceptualization and active experimentation (Module Guide 2007). This project demonstrates planning, research and implementation underpinned by my professional experience portrayed by RAL at Level 8 claims and allowed the transformative learning produced by interaction between content and experience (Kolb 1984) to be expressed by tangible outcomes. The Level 8 credits allowed me to further develop my professional practice in an innovative manner by combing the physical science traditions of my engineering and design practice with an anthropologically rooted ethnographic approach to synthesize and thereby create an original approach to boat/product design.

The most important project outcomes are the design of a concept fishing boat and the extension of the positivist discourse of design by ascertaining whether ethnographic analysis is viable in a design process. Additional outcomes are: a case study for industrial design students, a lines drawing of a traditional fishing boat, pending publication of the thematic analysis in an academic journal (and more expected to follow), and the dissemination of the design feature questionnaire results to the Malaysia's Department of Fisheries. This project also provided ancillary outcomes such as: 1) identifying and employing a visual stereotype as a component of the design method and as an archetype to 'bracket' the concept boat evaluation, 2) using clay modeling as an adjunct to interviews, 3) teaching a marine surveying course to

Malaysian professional marine surveyors, 4) providing suggestions that reduce chengal wood consumption, and 5) ongoing collaboration with my UTM colleagues.

My professional and academic backgrounds merged effectively into this project. My academic progression has logically concluded in this transdisciplinary project; going from the quantitative aspects of my BSc curriculum in mechanical engineering to the broader arena of organizational behavior studied for my MA degree.

In describing experiential learning, Lindeman stated, "experience is the adult learner's living textbook" (Lindeman 1926/1989, p.7). My professional career was directly applied to this project because the complex process of design is difficult to learn by any other means but experience. Moreover, my management of complex technical projects allowed this transdisciplinary effort to proceed efficiently. My RAL at Level 8 claim in this area related to a technically sophisticated system with complex business relationships, which can be related to this project because their exist complex, layered relationships connected with fishing boat design. These complex layers are comprised of 1) differing stakeholder concerns, 2) environmental changes, and 3) large scale policy changes. The stakeholder concerns ranged from the purely financial of absentee owners to the safety concerns of the crew. The principal environmental changes included the increasingly rare and expensive chengal and fishery depletion, especially by trawlers. Policy changes loom over the fishing boat stakeholders, most strikingly the Malaysian government's desire to reduce the number of small boat fishermen. In addition, the external affects of increasing fuel prices and competition for fish by other nations cannot be controlled by the stakeholders. This project compelled me to understand these forces so I could secure a broader comprehension of underlying design motivators. These large scale and complex relationships can easily be lost when measuring the size of a boat's window or distance from a helm seat to a gauge. It is for this reason my RAL at Level 8 claims reflect the broad perspective required for undertaking this project.

The development of a culturally appropriate, data driven, boat design has been central to this project. Within the overall boat layout, with its gentle evolution from the archetypical design, my design includes several specific details such as: 1) a hardened mounting pod supported by a reinforced arch on the pilot house; 2) a lightweight, retractable sun shade; and 3) a configurable pilot house module design with either an exhaust riser or watertight locker. These design details reflect the same type of innovative detail described in my RAL claim for patented designs.

Project Overview

An industrial designer considering the design of a new fishing boat in a foreign culture must fully understand the stakeholders' positions. The designer must disarm himself or herself of standardized approaches to design and integrate mechanistic and non-mechanistic concerns with aesthetic and cultural sensitivity. However, innovation will often encounter resistance in any population, therefore the designer needs to grasp the stakeholders' identity, values and concerns, as well as their propensity to resist change. Moreover, aesthetics can be subliminal; something may look beautiful because it looks strong and that strength is the salient value to be expressed in the design. Aesthetics are subjective but arise, in part, from cultural and environmental forces. These influences can be synthesized with universal elements of design such as proportion, movement, balance and rhythm to arrive at an aesthetically attractive design.

The aim of this project was to learn and integrate non-mechanistic forces in an innovative manner with boat design principles, and in this way advance the design profession. This project endeavored to understand stakeholder concerns through ethnographic methods. These methods included semi-structured interviews, observation and questionnaires for obtaining data on boat designers/builders and fishermen. In addition, data from non-fishing boat owners, boat repairers and a fish broker was obtained through interviews. This inquiry provided non-mechanistic concerns, such as notions about safety and comfort as well as broad insights into boating community interactions and general resistance to design change. This project also obtained data on mechanistic concerns such as equipment, boat layout and performance. A visual stereotype, referred to in this project as *Design B*, was also identified to produce a baseline case for developing a new design.

Data was generated through by ethnographic methods were coupled with naval architectural/engineering principles to develop a concept design for a Class B fishing boat, referred to in this project as *Design A*. The concept was compared against the visual stereotype and contemporary Western style, forward deckhouse design using a questionnaire given to traditional fishermen. From these findings, I developed a conceptual fishing boat design and a case study exercise suitable for students of industrial design.

Project Approach

I divided the project into two phases. The first phase involved the acquisition of data that would be used in my concept boat design. The second phase appraised my design using a population of traditional Malaysian fishermen. The project investigated three populations: boat designers/builders designated as *Group 1 (n = 6)*, and two groups of fishermen working on traditional boats. One of these fishermen groups, referred to as *Group 2 (n = 41)*, was used to obtain background data for my design work. Another group, designated *Group 3 (n = 12)*, was used in Phase II as evaluators of my concept outline drawings and clay models. Additional fishing and boating related informants were also involved as described in Chapter 4.

Group 1 and Group 2 populations were from the east coast of peninsular Malaysia facing the South China Sea, and the southwestern coast facing the Strait of Malacca. The Group 3 population came from southeastern coastal Malaysia, specifically Endau and Mersing.

In addition to the ethnographic study, photographic images were measured and superimposed to identify the visual stereotypes, that is, the visual profile that stakeholders' would expect to see in a traditional fishing boat. A hull measurement of a newly constructed Kuala Terengganu boat was also performed from which lines drawings were produced. Literature related to Malaysian fishing was studied and triangulated with ethnographic data to produce a thematic analysis. A creative product analysis matrix (CPAM) was used in my self-appraisal of the three designs: 1) visual stereotype, 2) concept (Design A), and 3) contemporary Western, (Design B) that would be proffered for Phase II study. The CPAM rubric allowed for critical reflection and a measure of design creativity associated with the boat designs.

The Phase II study provided feedback on the concept design as well as a rating of specific design features. The results of this study suggested that the fishermen did not desire the contemporary Western, deck forward design based on ratings of beauty and overall suitability. The contemporary Western design was thought, at least by one respondent, to be made from steel and therefore incapable of providing the flotsam of a wooden boat. Because traditional Malaysian fishing boats do not have life rafts, a metal boat was thought to be a perilous design. While the Group 3 population was only comprised of two Chinese Malaysians, these two respondents rated the contemporary Western design much higher than the Malay population.

The Phase II response showed that the concept boat was much preferred over the contemporary Western style boat, but the visual stereotype had the highest ratings for beauty and overall suitability. Responses to the ‘overall beauty’ question gave eight out of eleven respondents rating the concept boat greater than or equal to the stereotype, while three rated the concept boat below the stereotype. This ratio becomes seven rating the concept boat equal to or better, two rating it lower, if the two Chinese respondents are excluded. This result contrasts with the contemporary Western style boat, which gave only five out of twelve respondents rating the contemporary Western style boat greater than or equal to the stereotype, while seven rated the contemporary Western style boat below the stereotype. If the two Chinese respondents are excluded, this ratio becomes three rating the contemporary Western boat equal to or better, seven rating it lower than the visual stereotype. In both cases, only one respondent rated the concept and contemporary Western style boats better than the stereotype.

Responses to the ‘overall suitability’ question gave eight respondents rating the concept boat greater than or equal to the stereotype, while four rated the concept boat below the stereotype. This ratio becomes eight rating Design A equal to or better, two rating it lower if the two Chinese respondents are excluded. This result contrasts with the contemporary Western boat, which produced four respondents rating the Western style boat greater than or equal to the stereotype, while eight rated the contemporary Western boat below the stereotype. If the two Chinese respondents are excluded, this ratio becomes three rating the contemporary Western boat equal to or better, seven rating it lower than the visual stereotype.

This data suggests that the contemporary Western style, deck forward boat is unattractive to fishermen, while the concept boat is nearly equal in attractiveness as is the visual stereotype. However, evidence is not proof and is subject to interpretation. For example the two Chinese respondents' ratings for 'overall suitability' were at opposite extremes, so it is difficult to make conclusions for this ethnic group. Moreover, the appeal of innovative designs needs to be considered against the background of early innovators and demographic indicators.

This project identified a utilitarian design culture and a propensity to resist change. Resistance to change is strong among fishing boat stakeholders, not because they necessarily wish to preserve tradition, but due to fear of failure. The stakeholders with the most influence in design are the boat owners who guide high level design issues such as boat size and engine specifications but do not get involved in design minutia. The project concludes that boat designers/builders do not modify their designs in response to evolving fishermen's needs. While these attitudes are not unique to Malaysia, it is common to resist changes to something one depends upon for personal safety; however, this high level of resistance made the identification of the visual stereotype especially important in this project. Because the resistance to change is so important in my design approach, I presented the issue extensively in this project and note that a new design in this culture might be thought to be successful if it is evaluated to be at least equal to the stereotype.

The CPAM provided a rubric for assessing creativity and aids in parsing a design concept; however, a high rating does not necessarily suggest market attractiveness. For example, the CPAM's categorization of 'surprising' is probably not a good quality in a fishing boat design because the dependence fishermen place on the safety of their boats does not compel them to desire 'surprise'.

Unique Aspects of Project

The heart of this project was the ethnographic method and creative deference to this data, consistent with the goal of grounded theory. In addition to the ethnographically founded approaches, the original contributions provided by this project are 1) the concept boat design, 2) the industrial design case study, 3) lines drawing of a traditional hull, and 4) design feature questionnaire findings. In addition to these professional accomplishments, the preliminary ethnographic investigation was unique in using clay modeling as a method of communicating and acquiring data. Reliance upon a visual stereotype was also a unique aspect of the project, as was the bracketing of my new design between the visual stereotype and a contemporary Western hull.

Design Overview

The concept boat design description is provided in detail in Chapter 5 and Appendix 11. The concept boat is 14 meters long and the deckhouse and above waterline design is suitable for varied applications in Malaysia. However, the underwater hull form shown in the concept design is intended for east coast (South China Sea) operation. The block coefficient could be increased for west coast (Strait of Malacca) usage. The design has a full bow and a low block coefficient to improve seakindliness. The low block coefficient also lowers the volume which has the licensing advantage of lower GRT to keep the boat in the Class B category. The licensing issue could change however, and the Malaysian regulatory environment may drive design change. Specifically, the Malaysian government has voiced its concern for the inefficiency of small boat operations and desire to move fishermen into other industries. In addition, Malaysia could potentially restrict fishing practices such as trawling or mandate materials and equipment used in fish preparation and storage.

Besides styling changes, the design includes safety features such as a life raft, deck railing, more freeing ports, watertight hatch covers, uncluttered side decks, provisions for safety harnesses, bilge alarms, refrigerant alarms, grounded antenna masts and grab railing. Moreover, the deckhouse is lightened to improve stability. This improvement is accomplished by an aluminum pilothouse and fabric sun screen. The deck's lightweight waterproof hatches also improve stability.

Crew accommodations include a toilet, sink, waterproof storage, ergonomic helm, and convertible furnishings. Other technical innovations included refrigerated fish holds; lightweight, retractable sun shield; and hardened mounting pod for pilothouse attachments. While allowing attachments to be easily affixed at the top of the pilothouse that may invite innovations that degrade stability, this is a better alternative than frameworks of massive wooden timbers. The hardened pod allows for innovation and adaption, but the affects on stability need to be carefully considered before implementing.

Some of the design improvements add cost, most notably the life raft and watertight hatches; however, these are important safety features that could not be omitted from the concept design. Moreover, these changes promote crew confidence, especially during the monsoon season, which potentially improves economic efficiency. However, it is important to note that fishing during the monsoon season could have affects on the sustainability of fisheries, which this project does not address except to present the matter as an ethical consideration in Chapter 3.

Implementation and Recommendations

The best approach to implementing this design is through retrofitting traditionally built boats or through speculatively built boats. Current traditionally built boats could include the high impact improvements of the deckhouse, hatches and refrigerated holds described in this project. These features could be added to old hulls which would extend their design life. Moreover, traditionally built hulls and decks could employ steel or FRP, including moldable polymeric composites, for some of the structural members such as the keel bar and stem post. These members currently use massive, expensive and unsustainable chengal timbers. More sustainable woods could also be used and covered with FRP to improve watertightness, weathering and resistance to marine growth. These approaches would allow boat designers/builders to maintain their traditional approaches except for replacement of their designs for deckhouses, hatches and holds. Alternatively, private enterprise or the Malaysian government could build speculative boats that have demonstrable long term economic return on investment. An innovative design that is speculatively built would require some builder or government supported guarantee of their longevity, fuel economy and reliability.

It is unlikely traditional boat designers/builders would discard their designs in favor of the concept design developed in this project due to social forces of identity and dissonance. This concept has distinct advantages, primarily in terms of crew safety and boat efficiency that are ultimately helpful to the owners and crews. However, the other stakeholders, namely the boat designers/builders could be adversely affected by this design. Traditional boat designers/builders are the most affected by design change because they make few changes to their designs besides engines and electronics. However, traditional boats have several changes looming: chengal is decreasingly available and increasingly expensive, fuel is becoming more expensive, and the Malaysian government is interested in decreasing poverty rates among fishermen and reducing overfishing. The availability and cost of chengal have already encouraged the development of FRP boats and this trend away from wood should be expected. Fuel is subsidized and for Class B operation with shorter travel distances, fuel costs are less of an issue than with Class C and C2 boats, which venture farther offshore. However, higher fuel cost will encourage more efficient hulls and propulsion systems. While these issues are driven by economic forces, one must note that the Malaysian government is active in many aspects of the economy and legislation could result in changes to the traditional fishing community beyond what the world of science could introduce.

If modern manufacturing methods are introduced into Class B boats, a design needs to be developed and standardized. Moving this Class B boat forward into production necessitates the involvement of Malaysians in design styling issues. Malaysians should also be involved with the detailed development of the hull, propulsion system, tank testing, and prototype testing. This boat concept design does contribute an outside perspective which can beneficially contribute to a final design. Moreover, this project identifies key non-mechanistic concerns with an approach to objectivity that is articulated by my positionality, methodology and research data. Additionally, the creative elements, which a Malaysian might view as a presumptuous intrusion from a non-Malaysian, are largely subordinated to the data and standard design fundamentals of proportion, movement, balance and rhythm.

Project Dissemination

The concept design has been given to all the boat designers/builders who participated in this project as well as the Department of Fisheries. The design and questionnaire results from Phase II have also be given to the Department of Fisheries. The drawing of the measured hull has been given to the boat builder/designer of the hull in Kuala Terengganu. The results of the thematic study and questionnaire results have been included in a report to UTM. The industrial design case study will be used in my industrial design classes and has been disseminated to other industrial design instructors.

Future Work

A further amplification of this project would identify the different attitudes of Malay and Chinese fishermen with respect to boat design and usage. As my Phase II data suggested, there may be a difference, but I did not explore this matter. Another important question is identifying the attitudes regarding lifestyle versus economic prosperity. This concept boat introduces some new technology and provides a more seaworthy vessel that can fish during high sea states as often encountered during the monsoon season. This design has the potential to compel fishermen to fish more days and under adverse conditions, which affects the fishermen's lifestyle but potentially enriches him financially. Additionally, an all weather fishing boat has unknown affects on the sustainability of the fisheries.

Many of the technical features of traditional design would be interesting to investigate in the future. These relate more to construction than design. These open questions include aspects related to the unique monocoque construction and its dependence on trunnels. I saw several boards split down the middle where the trunnels produced stress concentrations. I would be very interested to characterize the affect of interplank trunnels on strength, flexibility (fatigue resistance) durability, and propensity to crack planking. Can the planks be made thinner and therefore consume less wood? Could skeleton construction use less wood? I also wondered if a composite plastic dowel would work satisfactorily. The wooden trunnels swell when wet and have high adhesion as a result. However, they require much labor to produce, whereas a molded material bonded with a flexible adhesive has the potential to produce an equally strong, pliant joint.

Another technical question arose in this project, namely identifying the better plank sealant, bark or rope. Bark requires better plank fit up than rope and is generally more difficult to use. While informants told me the bark would last ten years, it seems modern sealants would be more durable and easier to use.

The economics of fishing and boat building were not investigated in any detail but this subject would provide fascinating insight into boat design motivators as well as the fishing community in general. In addition to crew reselling fuel and keeping part of the fish catch, there were many glimpses of matters that could be investigated from an economic perspective. For example, I saw many abandoned and decrepit boats around the docks and I never received a good explanation as to why the chengal was not reclaimed for new boat construction to save costs. I found this very intriguing and I heard odd stories in connection with these derelict boats. One economic factor that relates closely to this project is to determine if a fishing boat that is sufficiently seaworthy for high sea states would motivate fishermen to fish during the monsoon.

Recommendations for Ethnographically Based Design Practice

Ethnographically driven design has the advantage of broad application and allows a designer to work outside his or her culture to create effective designs. Styling elements can be incorporated by learning the aesthetic traditions and values then trying to incorporate these attractively. However, this design endeavor may be most effective in a team setting. Team work can enhance the rigor and objectivity of ethnographic methods by reducing biases and preventing a researcher from getting sloppy with the interviewing process, or missing data contrary to evolving themes.

Inclusion of a stakeholder in the aesthetic development would also be a beneficial approach because this aspect of design is highly subjective and could gain from stakeholders' contributions. While this sort of 'design by committee' can produce uninteresting results, in the context of design for a foreign culture it seems appropriate. The most helpful aspect of this project is in asserting that non-anthropologists can use tools of cultural anthropology in their disciplines. This transdisciplinary approach is a powerful method in producing professional achievements, particularly for mature practitioners. Professions commonly develop identities that close off their world to others. This social phenomenon occurs in engineering, art and anthropology. This project has endeavored to transcend these disciplines and engage all stakeholders to demonstrate the practicality of a transdisciplinary paradigm.

One way to gauge the success of my transdisciplinary approach is to observe that my concept design is personally unsatisfying. From a functional standpoint, I would have preferred a deck forward design with a large working deck and fish holds located astern. Additionally, retaining bulwarks and tiny crew accommodations are particularly frustrating. I would also require FRP covering of the horizontal surfaces to improve watertightness.

While the material of construction for the concept boat could be wood, FRP, aluminum or steel, the design is primarily directed at traditional wood construction. The use of massive chengal timbers for the keel and stem are ecologically unattractive. Moreover, I have put little personal style into the boat; the styling elements derive from Malaysian iconography, traditional styling principles, and the visual stereotype. Therefore, I am left with a void, a lack of personal ownership of the design. However, I have arrived at the goal of developing a favorably received design for a traditional Malaysian fishing boat based largely on ethnographic study and analysis. Moreover, my personal goal of exploring whether a designer can employ tools of social science to improve the effectiveness of design and enrich professional practice was satisfactorily accomplished.

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Appendices

Appendix 1

Project Reflections

Boat design requires a blend of technology, marketing insight, cultural understanding and aesthetic sensitivity. Consequently, the methodology to identify and interpret pertinent and culturally appropriate information is challenging and varied. In addition to my design background, the managing of complex relationships as well as sensitivity to business considerations has been one of the principal qualities I bring forward from my professional background. I investigated methodologies that would allow me to gain insights for my creative and technical expression of boat design. I determined that ethnographic research methods (as well as visual stereotypes, anthropometry, and creativity appraisals) would be the most helpful when paired with engineering methods in arriving at my design goal: a design consistent with both mechanistic and non-mechanistic requirements of the stakeholder.

This project allowed ethnographically derived data to motivate a design. This project was framed so I would investigate an unfamiliar culture, design a traditional fishing boat based on this learning then evaluate my design. My initial plan was to use a cultural consensus questionnaire to ensure that my population represented the fishing community. The cultural consensus was intended as an approach to authoritatively assert that I was gaining information from actual fishermen and not being misguided. I developed a true/false questionnaire in accordance with guidelines provided by Bernard (2006). However, when I discussed the idea with my colleagues at UTM, they thought it would be unwise. They suggested that a test of any sort would be intimidating and unhelpful. My initial experiences with fishermen led me to understand that the context under which I was interviewing them, namely on or near fishing boats, and the appropriateness of their responses would be an indication of their relevancy to my study. I elected to omit the cultural questionnaire as a burdensome and disruptive element of my work. Although I never had doubts about the appropriateness of my informants, I did not like altering the logical progression I had mapped out in my design proposal.

I was expecting every observed design feature to have some beautiful, long standing, and justifiable reasoning behind it. This was not the case. A powerful first impression was the lack of certain design optimizations such as streamlining rudders and bilge keels. Based primarily on freeing port and hatch design, I quickly surmised that typical fishing boats do not encounter green water. I had to actively avoid theoretical bias and signaling informants to provide supportive evidence for this theory. I was also surprised the boat we measured was built with a high stern sheer through the deckhouse even though it was reported (and observed by me) to be uncomfortable to sleep on due to its slope. The boat builder had been building it this way for decades and was not going to change, even though the change would be free in terms of material and easier to construct. This imperious attitude, that the designer knows what the user wants, was very common in industrial products in the US, but design approaches have moved towards user-based design in the consumer age of the late 20th century. These design issues forced me to struggle with my confident assertions that the designers were wrong. I was compelled to seek deeper understanding of why "obvious" design changes were not included. I found only partial answers to my logical impasse in identifying the Malaysian design culture containing strong resistance to change and perspicuity. Additionally, I concluded that lifestyle was more important than fishing productivity but this was difficult to characterize, illustrating that ethnographic study leads to more unanswered questions. While the project was framed around grounded theory's socially derived meanings, I saw the void that would have been filled by phenomenology's understanding of the essence of a phenomenon. But I knew this void could not be filled.

The potential for bias in my project was aided and exasperated by the fact that I was never a true participant. I was always an outsider and therefore had a limited ability to identify nuances. However, being an outsider allowed me to observe and interpret data in a different fashion than Malaysians. Moreover, this outsider perspective was a key feature of the project, namely testing whether an outsider can design something like an insider using primarily ethnographic data rather than enculturation to motivate the non-mechanistic elements of design. Another advantage of being an outsider is the ethnic divisions and underlying resentments between Malays and Chinese may have allowed me to be considered a less threatening investigator than, for example, a Chinese interviewing a Malay.

I felt comfortable with the validity of my observations and included more photographs than I originally intended for this study because they offered the proof my engineering-oriented thinking seemed to demand. This photographic evidence was especially important because I was unable to use discourse analysis or statistical approaches with my ethnographic data.

I struggled too with not allowing this project to be a travelogue but clearly frame the project as an ethnographic study applied to design. However, the ethnographic study was challenging in many respects. I became tired of walking around the docks asking the same questions while keeping an open mind about data that contradicts my hypotheses. Especially when alone, I felt a bit pathetic walking the docks with my satchel, clay and weak linguistic skills. These wanderings reminded me of sales calls, which I did infrequently during my career but did not find satisfying. Sales calls could be a large waste of time with much waiting and idle chattering. I like to make obvious progress with my time so walking around trying to find appropriate informants relied on luck to a larger degree than I normally accept. Ethnographic study required good personal skills; the ability to be friendly, network and especially persistence. Many aphorisms are offered about passion versus persistence but I found persistence was the key personal requirement because I needed to get many individuals' response even when they started sounding the same or when I thought I knew what their answers would be because I had heard it so many times before. A passion for boat design only took one to the dock, it was not enough to sustain hours of wandering with a happy face.

One problem that arose during my initial Phase II inquiry was that a crew responded as a group with the skipper guiding the group discussion. This introduced group dynamics that were disruptive to my epistemology. Fishermen, especially crew, were at the bottom of the hierarchical order of stakeholders affecting boat design and were best interviewed alone. Even though I tried to find root motivators for design features, sometimes I failed, such as with the omega hull in Tumpat where neither the builders nor the owner knew why the feature was present. When reflecting upon methodology, I must consider what would have happened if I used other approaches. For example, a case study of the Kuala Terengganu boat builder I measured along with the fishermen that fished with his boat design would have provided a deep, tightly focused insight. The study would be logistically easier because it was geographically more focused and the results carefully developed around these specific stakeholders. However, a case study would not have achieved my broader goals in seeking data for a culturally appropriate design. Another method that would have been helpful is a focus group which critiqued my concept design. A focus group would have given me rich, textured insight into the positive and negative attributes of my concept design. A dialogue with participants would have been very interesting to me because, while the questionnaire could be administrated effectively, it was a stark instrument and left me wanting more insights into the reasoning behind answers.

This project endeavored to verify that ethnographic approaches could be the principal method in a transdisciplinary approach to creative boat design. A designer is naturally compelled to develop new designs that satiate the ego rather than allowing user-derived evidence to motivate design. However, user-derived data obtained from ethnographic study is especially vulnerable to misinterpretation because it is derived in the context of interpersonal relationships between the ethnographer and the informant.

This project verified the appropriateness of transdisciplinary approaches, in that the concept design was much different than what I would have otherwise designed, and therefore contributed to my professional practice. The concept design is missing mechanistic and styling features I would personally wish to include because the styling features tend to point at the designer's vanity while the mechanistic features, such as a larger working deck, would not be readily accepted by some of the stakeholders. My design approach was strongly influenced by the observed resistance to change, leading to a concept design that was more evolutionary than revolutionary.

The data spoke. I subordinated what I might have thought of as 'pure creativity' to this data, recognizing that my creativity derives, in part, by my enculturation, of which much is not universally applicable. Within my community of practice, where we blend creativity and technical skills, we must listen, rest our vanity, punch holes through the walls encircling specific disciplines, and embrace transdisciplinary approaches.

Program Reflections

My two decades of design practice have produced commercialized products and systems as well as the management of their implementation. In this program, I have knitted these experiences together to launch upon a transdisciplinary study founded in ethnography. This transdisciplinary approach has moved my positivist approaches to design towards the interpretive in a manner that will be embedded in my future design work. This program has broadened my design methods, causing me to shed self-imposed constraints on the form and interpretation of data. I have learned that data comes in many forms and extracting data requires a variety of methods.

One is challenged, when in the company of engineers and designers, to engage in ethnographic study with the rigor of an articulated framework. My experiences from this program will allow me to pursue transdisciplinary methods with the same rigor as I have exercised in engineering because I will be confident in the validity and usefulness of the results. I will be a voice for transdisciplinary methods from within my profession.

One quickly becomes defined by one's discipline as we witness the academic, professional, and even legal walls constructed around the discipline. These barriers are not necessarily bad and are often justified as means to assure public safety, so that my Professional Engineer license (akin to the British Chartered Engineer) assures the public that my designs are competent and safe. However, these walls can create an insidious environment where 'hard' science is honored and everything else becomes noise. While my educational foundation fully rests on science and I have a deep affection for the mysteries revealed by the natural sciences, I recognize that the 'hard' sciences have waded into matters, most powerfully seen in such fields as nuclear energy and genetics, which requires involvement beyond science.

Science can also give an incomplete picture of truth. Newton was able to mathematically describe motion in a valid fashion for his context of low speed, high mass objects. However, his descriptions of motion were ultimately wrong. Einstein expanded these descriptions into a 'universal' truth by considering relativistic (high speed, low mass) effects. Newton's data was valid, relevant and useful but it was not fully accurate. Philosophers such as Paul Feyerabend have investigated the limits of the scientific method, but I recognize that science can be blind to the broad swath of culture and therefore fails to provide all data and guidance for culturally appropriate designs. The professional practice of design is complemented by interpretive approaches that fall outside the natural sciences. However, for me to make sense of the value of non-mechanistic, stylistic design elements I must recognize the intangible, scientifically unapproachable aspects of these elements as promulgated by the Vienna Circle's logical positivism. Not all questions are scientifically answerable and some can only be judged based on their value to the individual.

This program has provided an environment in which I was free to explore and reflect upon different ways of learning. This program has provided a structure to reflect on my work as I endeavored to look through the wrong end of a telescope to compress my work experience onto the pages of flat paper. The program provided a framework for organizing and relating my disparate experiences to reveal a gilded thread for approaching creative design. However the gilded thread is interrupted by many gatekeepers. Like engineers, ethnographers are defensive of their profession and would argue that one cannot just read some books and go out and "do ethnography." However, if ethnography is closed to engineers and designers, exclusionary barriers are raised that cripple both design (by failing to consider data that can only be approached ethnographically) and ethnography (because it becomes academic and has reduced practical application). Experienced practitioners should blend their disciplines and use their evolving education to boldly travel far from where they may have started their professional careers.

The most positive aspect of my experience with this program is enlarging the trough from which I feed my designs. Physical sciences, life sciences, math, anthropology, sociology, psychology and economics can all be tapped for methods that improve design. So I keep my mind open to new methods for improving design; borrowing from all disciplines with alacrity and continually explore.

Appendix 2

UTM UNIVERSITI TEKNOLOGI MALAYSIA
Pejabat Pendaftar

Pejabat Pendaftar
Universiti Teknologi Malaysia
81310 UTM Skudai
Johor Darul Ta'zim
Malaysia

Tel: +(6)07-5533333 Faks: +(6)07-5561722 http://www.utm.my Emel:admin@pendaftar.utm.my

RUJUKAN KAMI: UTM.02.01/12.23/1/3/10 Jld. 4 (4) 8 July 2009
RUJUKAN TUAN:

Assoc Prof. Thomas Ask
Pennsylvania College of Technology
Amerika Syarikat

Dear Sir,

APPOINTMENT AS VISITING PROFESSOR

On behalf of the University, I am pleased to offer you the appointment of **Visiting Professor** at the **Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, Skudai, Johor.** This appointment commences from **25th June 2009 to 15th November 2009.**

2. The terms and conditions of this appointment is as stated in **Appendix A**. As the Visiting Professor the faculty, you are expected:

i) To advice the faculty and the University on the future development and related studies in ***Fishing Boat Design;***

ii) To do research, consultation and publication in your specialised area and;

iii) To introduce the University to the International Community.

3. I would like to take this opportunity to welcome you to Universiti Teknologi Malaysia. Please complete and return the letter of acceptance as enclosed. **(Appendix B).**

Thank you.

Yours sincerely,

HASSAN BIN HUSIN
Senior Deputy Registrar
On behalf of the Vice Chancellor
☎ : 07-5530474
🖳 : hassan@utm.my

d/ surat pelawat/prof pelawat_fkm/kai/lynn

Appendix 3

Semi-structured Interview Schedule

Technical

- What sort of waves do you encounter?
- What kind of stability do you like, tender/stiff?
- How much freeboard do you prefer?
- How high a gunwale or railing do you think is necessary?
- Does wood or construction technique dictate shear or overhang?
- What wheelhouse position do you prefer?
- What limitations do you have for the boat draft?
- What limitations do you have for the boat beam?
- What limitations do you have for the boat length (LOA)?
- What are your preferred positions of fishing equipment?
- What are your preferred positions of engine controls?
- What is your preferred position of helm?
- Number of crew typical? Crew desired?
- Load of fish maximum/typical?
- Where is the fish load located?
- Where are stored nets located?
- Have you heard of planks breaking or water leakage due to failure of plank dowels (east coast only)
- Do you get green water aboard? Where and under what conditions does green water occur?

- Do hatches ever leak?
- Does water ever get into the engine compartment?
- What happens to chengal after 30 years? When are they finally condemned?
- How often is the wood replaced?
- What were designs like 50 years ago?
- How do large boats differ from small boats, say Class A vs B vs. C?
- What led to large boat design and construction methods?
- What dictated the propeller location?
- What dictated the engine location?

Long Term Motivators

- Do you want your children to become fishermen?
- How often are boats resold?
- How long to boats last?
- What finally condemns them for scrap?
- Does the propeller ever come out of the water?
- Are the boats difficult to control at high sea states?
- Over the last 10 years has your design changed? Has it been influenced by some technology?
- What did boat designs look like 50 years ago?

Perception about science

- Do you think naval architects can improve the boat design?
- What do you think about “modern” FRP, aluminum and steel fishing boats?
    - Compared to chengal,

- Do they last as long?
- Are they as easy to maintain?
- What is their motion at sea?
- Any other advantages or disadvantages?

Fishing Motivators

- Are you concerned about over-fishing?
- Are you concerned more about other Malaysians or foreigners?
- Are you concerned with being at sea too long?
- Do you try to make Friday prayers? (Malays), temple/church (Chinese)
- Why did you become a fisherman?

Aesthetics

- What is preferred color scheme if not constrained by regulations?
- Do you add decorations or religious icons or any other ornamentation to the boat?
- If anything is added, can they be removed? What is their significance?
- Are any integral design elements related to belief system?
- Are any decorative elements related to belief system or tradition?
- Which part of the boat is dictated by aesthetics?
- What part of these aesthetic issues has been modified due to technical requirements?

Boating Community Interactions

- Do people compare boat performance or appearance?

Appendix 4

English Translation of Group 3 Questionnaire

Dear Fisherman,

I am studying Malaysian fishing boats and I would greatly appreciate your help in my study. Please complete the following questionnaire. You do not need to provide your name and address. Feel free to write any clarifying comments.

Thank you for your cooperation.

Tom Ask

Name: ____________________________________

Address: ____________________________________

____

____

Email: ____________________________________

Age: ______

Years fishing experience: _________

What size boat are you currently working on:

LOA _______

GWT _______

What type of fishing do you most commonly conduct (circle one):

trawler

purse seiner

traps

nets (besides trawling)

other (specify) __________

Fisherman Questionnaire

Please answer questions 1-8 as they relate to the boat shown below.

	Question	**Strongly Disagree**				**Strongly Agree**
		1	**2**	**3**	**4**	**5**
1	This boat is safe while handling fishing gear					
2	This boat will allow water onboard in the waves I encounter					
3	This boat will have minimal pitching in the waves I encounter					
4	This boat is easy to dock					
5	The boat hull is beautiful					
6	The boat deckhouse is beautiful					
7	The overall boat design is beautiful					
8	This boat is best suited to my type of fishing					

Fisherman Questionnaire

(Design Preferences Questionnaire)

	Question: **I would like the next boat I work on to have:**	**Strongly Disagree**				**Strongly Agree**
		1	2	3	4	5
1	more freeing ports					
2	railing on foredeck					
3	higher bulwarks					
4	onboard freezer for fish holds					
5	second helm station					
6	life raft					
7	hoist					
8	chairs					
9	toilet					
10	fans					
11	air conditioned wheelhouse					
12	stove					
13	refigerator (for crew use)					

Are there any other features that you would like to see in your next boat?

Bahasa Melayu Questionnaire

Tuan Nelayan yang dihormati,

Selamat Sejahtera! Saya sedang membuat kajian tentang kapal nelayan Malaysia dan saya amat menghargai sekiranya anda sudi memberi bantuan dalam kajian saya. Sila berikan pandangan anda dan lengkapkan borang soal selidik ini. **Anda tidak semestinya memberi nama dan alamat anda**. Sila tuliskan komen anda secara bebas dalam borang ini sekiranya ada.

Ribuan terima kasih dirakamkan atas kerjasama anda.

Tom Ask

Nama (Tidak semestinya): _________________________

Alamat (Tidak semestinya):

____

____

Email (kalau ada): ___________________________

Umur: ___________________________

Jumlah tahun pengalaman dalam perikanan: __________

Apakah ukuran kapal yang anda sedang kerjakan:

Panjang Keseluruhan (LOA) ________

Muatan keberatan kapal (GWT) ________

Apakah jenis kapal nelayan yang anda paling kerap kali mengerjakan (sila **bulatkan** pilihan):

Kapal pukat tunda (*trawler*)

Pukat tarik (*purse seiner*)

Perangkap (*traps*)

Jaring (selain daripada pukat tunda)

Lain-lain (sila nyatakan) ___________

Soal Selidik Nelayan

Sila berikan pandangan anda bagi Perkara dari 1 hingga 8 yang berkaitan dengan kapal nelayan

	Perkara	**Sangat Tidak Setuju**				**Sangat Setuju**
		1	**2**	**3**	**4**	**5**
1	Kapal anda adalah selamat ketika mengoperasikan alat penangkap ikan					
2	Kapal ini membenarkan air terlimpah ke atas geladahnya apabila menghadapi ombak					
3	Kapal ini mengalami kecuraman yang kecil (minimal pitching) apabila menghadapi ombak					
4	Kapal ini senang masuk ke dok					
5	Kapal ini mempunyai rangka badan (*hull*) yang cantik					
6	Kapal ini mempunyai bilik dek (*deckhouse*) yang cantik					
7	Rekabentuk keseluruhan kapal ini adalah cantik					
8	Kapal ini sesuai dengan cara perikanan saya					

Soal Selidik Nelayan

	Soalan: Saya berharap bekerja di kapal nelayan yang mempunyai:	**Sangat Tidak Setuju**				**Sangat Setuju**
		1	**2**	**3**	**4**	**5**
1	lebih banyak lubang saluran air (*freeing ports*)					
2	pemegang tangan di geladak depan					
3	benteng kapal (*bulwarks)* yang lebih tinggi					
4	pembekuan di atas kapal bagi menyimpan ikan					
5	stesen pengemudi kedua					
6	rakit penyelamat					
7	pesawat angkat (*hoist*)					
8	kerusi					
9	tandas					
10	kipas					
11	bilik pengemudi yang berdingin sejuk					
12	dapur ringkas					
13	peti sejuk (untuk kegunaan anak kapal)					

Adakah alatan lain yang anda berharap terjumpa di kapal seterusnya? Sila nyatakan.

Mandarin Questionnaire

致尊敬的渔夫：

您好，本人正在进行一项关于马来西亚渔船的考察，我诚挚地希望您愿意抽出宝贵的时间，提供您的看法并完成这项问卷。您**不需要**写上姓名和住址。若是您有任何其他意见，也欢迎写出来。

对于您的支持，本人在此致以万二份感谢。

汤姆士•雅思 (Tom Ask)

姓名(非必要): ______________________

住址(非必要): ______________________

____

电邮(如有): ______________________

年龄: ______

从事捕鱼行业已多少年: ________

您所工作渔船的尺寸:

总长度 (LOA) _______

排水量 (GWT) _______

您最常在下列哪一类渔船中捕鱼(请圈出合适的选项):

拖网渔船 (*trawler*)

围网捕鱼 (*purse seiner*)

鱼笼 (*traps*)

渔网 (除了拖网)

其他 (请说明) _________

渔夫问卷

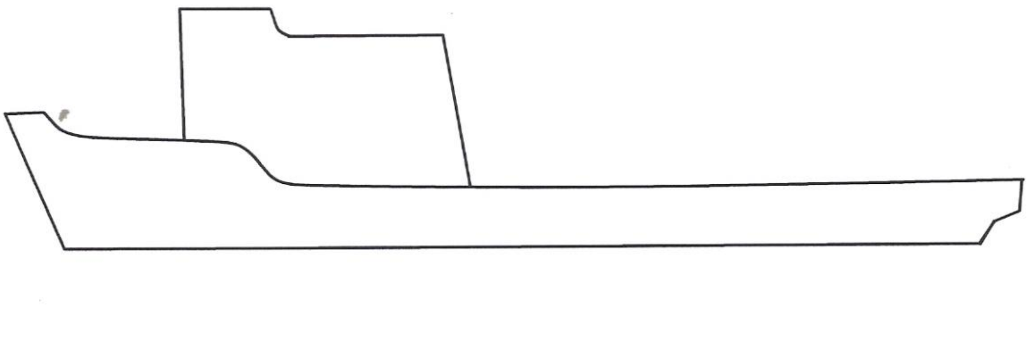
	提问：我希望我的下一艘船能够拥有以下的那些设备:	非常不同意				非常同意
		1	2	3	4	5
1	更多的排水孔 (*freeing ports*)					
2	船首甲板增设扶手					
3	位于船两侧更高的舷墙 (*bulwarks*)					
4	储藏渔获的冷冻设备					
5	副舵手驾驶台					
6	救生艇					
7	起重机					
8	椅子					
9	卫生间					
10	风扇					
11	备有冷气的驾驶舱					
12	炉具					
13	供船员使用的冰箱					

您是否有其他关于渔船设备的建议，请举出：

渔夫问卷

请就下列1–8项问题给予您的看法。

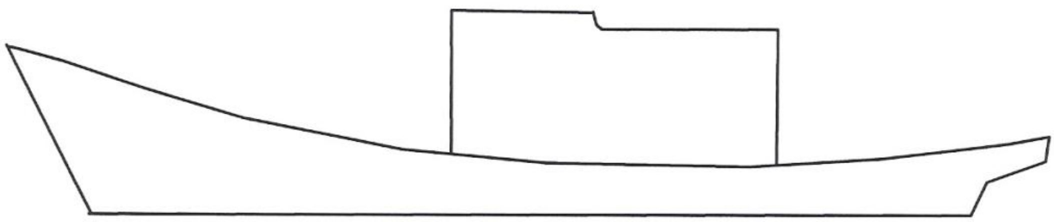
	问题	非常不同意				非常同意
		1	2	3	4	5
1	我的船在进行捕鱼（如搬运捕鱼工具）的时候是安全的。					
2	在遇到海浪时，我的船会让海水溅到甲板上。					
3	在遇到波浪时，我的船会有轻微的前后倾斜 (minimal pitching) 。					
4	我的船容易停靠在码头。					
5	我认为这艘船的船体(hull)很好看。					
6	我认为这艘船有好看的船舱 (*deckhouse*)。					
7	这艘船的整体设计是好看的。					
8	这艘船适合我捕鱼的作业方式。					



渔夫问卷

请就下列1–8项问题给予您的看法。

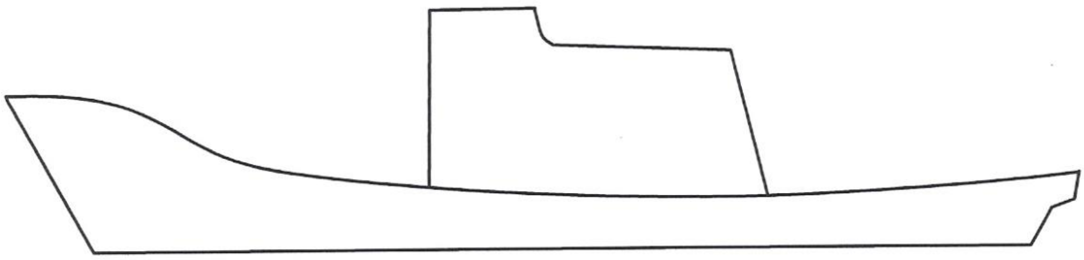
	问题	非常不同意				非常同意
		1	2	3	4	5
1	我的船在进行捕鱼（如搬运捕鱼工具）的时候是安全的。					
2	在遇到海浪时，我的船会让海水溅到甲板上。					
3	在遇到波浪时，我的船会有轻微的前后倾斜 (minimal pitching)。					
4	我的船容易停靠在码头。					
5	我认为这艘船的船体(hull)很好看。					
6	我认为这艘船有好看的船舱(*deckhouse*)。					
7	这艘船的整体设计是好看的。					
8	这艘船适合我捕鱼的作业方式。					



渔夫问卷

请就下列1–8项问题给予您的看法。

	问题	非常不同意				非常同意
		1	2	3	4	5
1	我的船在进行捕鱼（如搬运捕鱼工具）的时候是安全的。					
2	在遇到海浪时，我的船会让海水溅到甲板上。					
3	在遇到波浪时，我的船会有轻微的前后倾斜 (minimal pitching) 。					
4	我的船容易停靠在码头。					
5	我认为这艘船的船体(hull)很好看。					
6	我认为这艘船有好看的船舱 (*deckhouse*)。					
7	这艘船的整体设计是好看的。					
8	这艘船适合我捕鱼的作业方式。					



Appendix 5

Group 1 and 2 Informants

Group 1 Informants

Pontian Kecil

P4 Boat Repairer, Ethnic Group: Chinese, Age 50s.
P5 Boat Repairer (boatbuilder 20 years prior), Ethnic Group: Chinese, Age 50s.

Mersing

M1 Boat Repairer, Ethnic Group: Malay, Age 40s.

Pulau Ketam

PK1 Boatbuilder, Ethnic Group: Chinese, Age 50s.

Kuala Terengganu

T0. Boatbuilder, Located at Kampung Pulau Rusa. This is the site for the boat form measurement. Ethnic Group: Malay, Age 60s.
T1 Boat builder, located at Pulai Duyong, Ethnic Group: Malay, Age 60s.
T2 Boatbuilder, located at Pulai Duyong, Ethnic Group: Malay, Age 60s.
T3 Boatbuilder, located at Pulai Duyong, Ethnic Group: Malay, Age 50s. They make non traditional (frame first) wooden boats.
T8 Boat Repairer, located at Kampu Losong Haji Su, Ethnic Group: Malay.

Kota Bharu

KB3 Boatbuilder, located at Pen Kalan Kubor (near Thailand border), Ethnic Group: Malay, Age 50s.
KB4 Boat repairer, located at Pen Kalan Kubor. Also repair Thai boats. Ethnic Group: Malay, Age 30s.

Group 2 Informants

Pontian Kecil

P1 Boat Owner (one boat), Ethnic Group: Chinese, Age 50s.
P2 Boat Owner (one boat), Ethnic Group: Malay, Age 50s.
P3 Fisherman, skipper (retired), Ethnic Group: Chinese, Age 60s.
P6 Fisherman, Ethnic Group: Chinese, Age 20s.
P7 Fisherman, Ethnic Group: Chinese, Age 20s.
P8 Fisherman, Ethnic Group: Chinese, Age 20s.

Cherating

C1 Charter fisherman, offshore and river fishing, Ethnic Group: Myanmar, Age 40s.
C2 Fisherman, Fisherman, Ethnic Group: Malay, Age 40s.

Kuantan

K1 Boat Owner (3 boats), Fisherman, Ethnic Group: Chinese, Age 60s.
K2 Fisherman, skipper, Ethnic Group: (uncertain), age 50s.
K3 Former fisherman, now FRP boat builder, Fisherman, Ethnic Group: Malay name, Chinese appearance, Age 50s.
K4 Fisherman, Ethnic Group: Chinese, Age 20s.
K5 Fisherman, Ethnic Group: Chinese, Age 20s.
K6 Fisherman, Ethnic Group: Chinese, Age 20s.

Kuala Terengganu

T4 Fishery Dept., Ethnic Group: Malay
T5 Fishery Dept., Ethnic Group: Malay
T6 Fishery Dept., Ethnic Group: Malay
T7 Owner, yacht modeled after traditional Pinis, Nationality: German, Age: 50s.
T9 Boat Owner and Skipper, Ethnic Group: Malay, Age 50s.
T10 Fisherman, Ethnic Group: Malay, son of T9, Age 20s.
T11 Fisherman, Ethnic Group: Malay, son of T9 Age 20s.
T12 Fisherman, Ethnic Group: Malay, Age 20s.
T13 Boat Owner and Skipper, Ethnic Group: Malay, Age 50s.
T14 Fisherman, Ethnic Group: Malay (son of T13), Age 20s.
T15 Fisherman, Ethnic Group: Malay (son of T13), Age teens.
T16. Boat Owner and Skipper, Ethnic Group: Malay, Age 40s.
T17 Manager, Modern boat yard, Ethnic Group: Malay.
T18 Manager, Modern boat yard, Ethnic Group: Malay.
T19 Engineer, Modern boat yard, Ethnic Group: Malay.

Kota Bharu

KB1 Boat Owner and Skipper, Ethnic Group: Malay? (Mat Asri Mat Jau), Age 40s.
KB2 Fisherman, Ethnic Group: Malay, Age 40s.

Sedili

S1 Fish Broker, Ethnic Group: Chinese, Age 40s.
S2 Fisherman, skipper of S3s boat, Ethnic Group: Malay, Age 50s.
S3 Boat Owner (one boat), Ethnic Group: Chinese, Age 30s.
S4 Fisherman on S3 boat: Malay
S5 Fisherman on S3 boat: Malay
S6 Fisherman on S3 boat: Malay
S7 Fisherman on S3 boat: Malay
S8 Fisherman on S3 boat: Malay
S9 Fisherman on S3 boat: Malay
S10 Fisherman on S3 boat: Malay
S11 Fisherman on S3 boat: Malay
S12 Fisherman on S3 boat: Malay
S13 Fisherman on S3 boat: Malay
S14 Fisherman on S3 boat: Malay
S15 Fisherman on S3 boat: Malay
S16 Fisherman on S3 boat: Malay
S17 Fisherman on S3 boat: Malay

S18 Fisherman on S3 boat: Malay

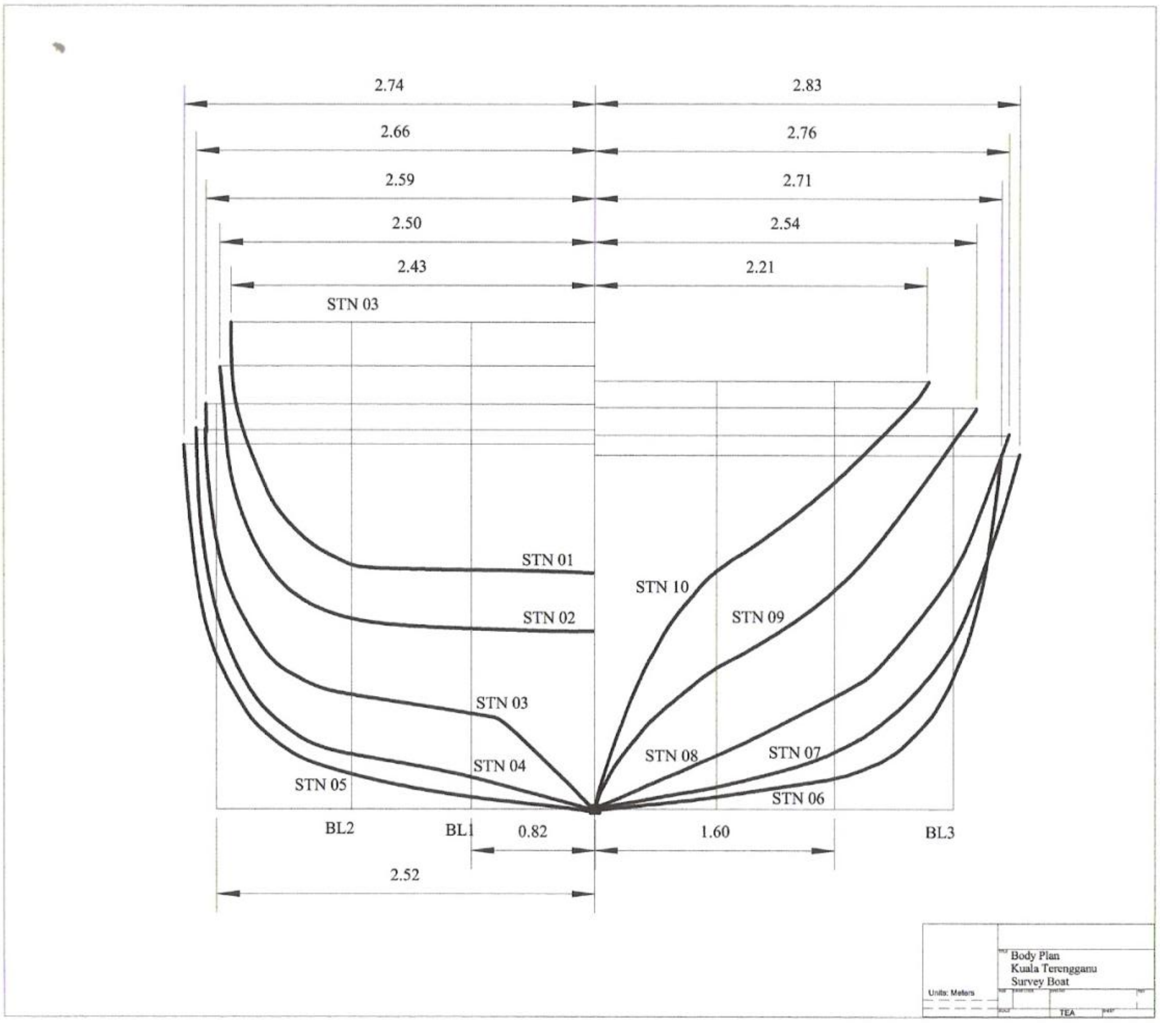
Endau

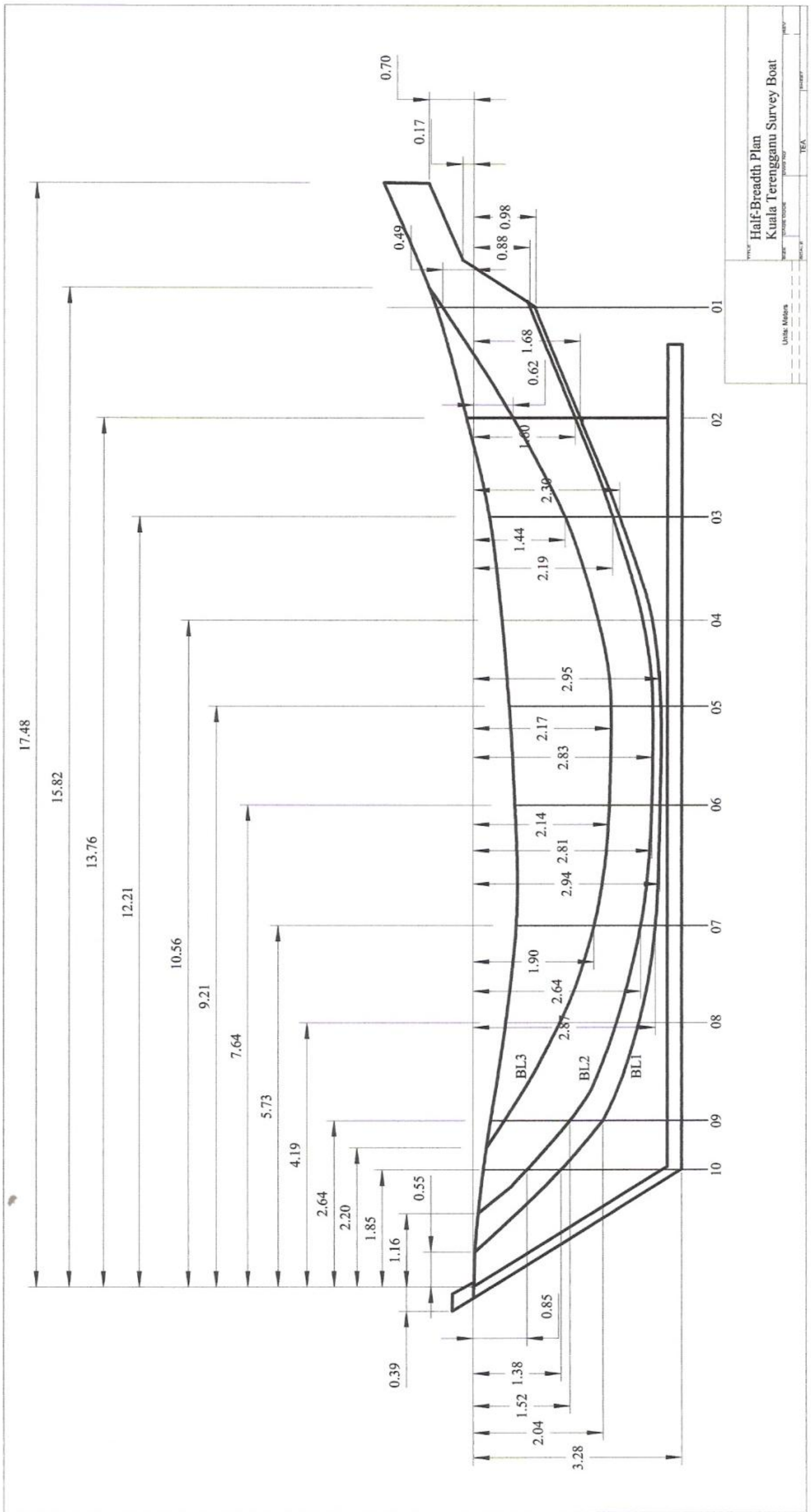
E1 Fisherman, Ethnic Group: Chinese, Age 50s
E2 Fisherman, Ethnic Group: Chinese, Age 40s
E3 Fishery Department, (enforcement), Ethnic Group: Malay, Age 20s
E4 Fishery Department, (licensing), Ethnic Group: Malay
E5 Fishery Department, Ethnic Group: Chinese
E6 Fisherman, Ethnic Group: Chinese, Age 40s

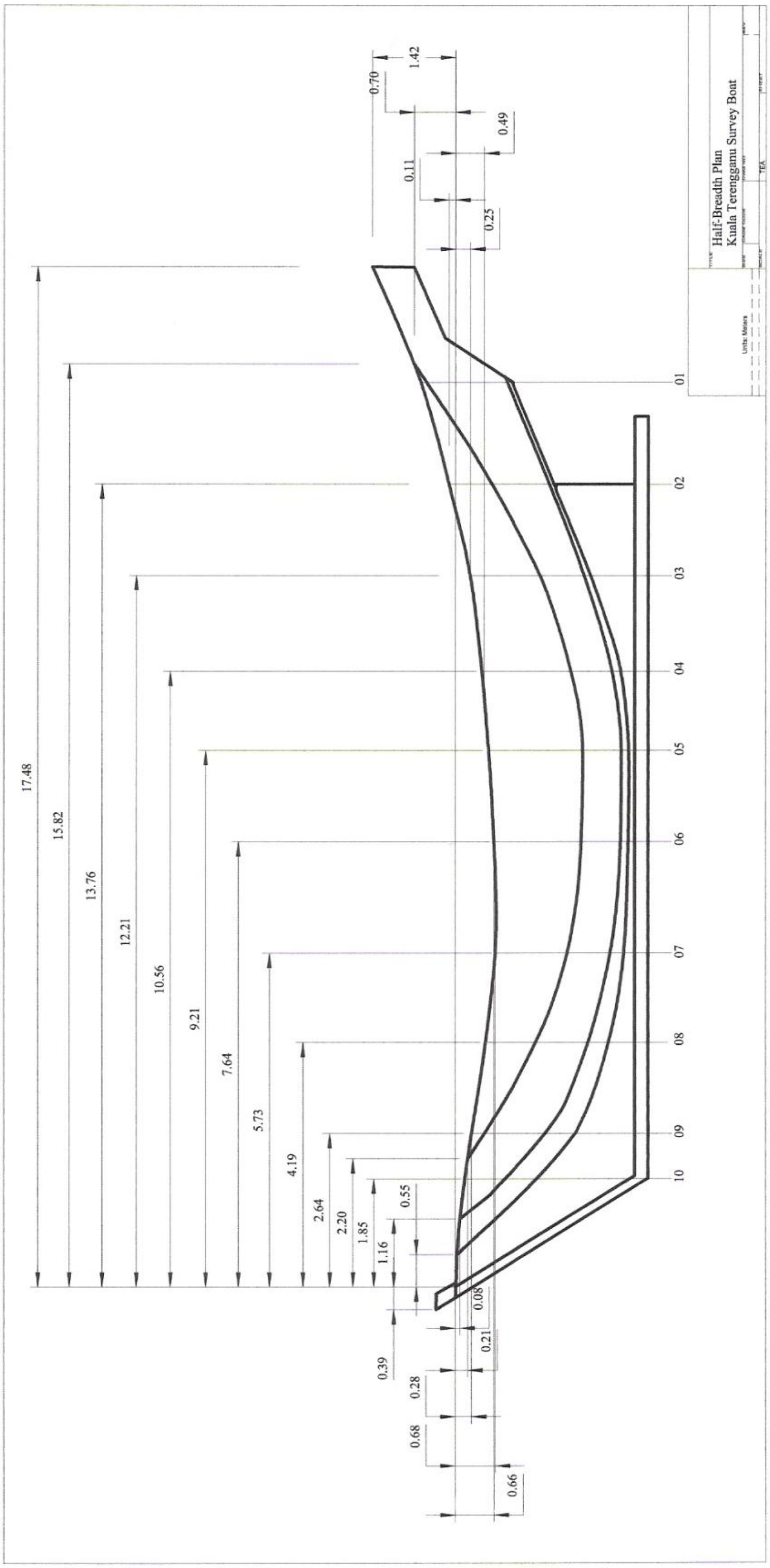
See Table 5.6 for Group 3 Informants

Appendix 6

Kuala Terengganu Traditional Fishing Boat Survey




Half-Breadth Plan
Kuala Terengganu Survey Boat
Units: Meters
TEA
01
02
03
04
05
06
07
08
09
10
BL1
BL2
BL3
17.48
15.82
13.76
12.21
10.56
9.21
7.64
5.73
4.19
2.64
2.20
1.85
1.16
0.55
0.39
0.85
1.38
1.52
2.04
3.28
1.90
2.64
2.87
2.14
2.81
2.94
2.17
2.83
2.95
1.44
2.19
2.30
1.60
0.62
1.68
0.49
0.88
0.98
0.17
0.70


Half-Breadth Plan
Kuala Terengganu Survey Boat
Units: Meters
17.48
15.82
13.76
12.21
10.56
9.21
7.64
5.73
4.19
2.64
2.20
1.85
1.16
0.55
0.39
0.28
0.68
0.66
0.08
0.21
0.70
1.42
0.49
0.11
0.25
01
02
03
04
05
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07
08
09
10

Evidence of Achievement

Appendix 7

Industrial Design Case Study

Designing a Class B Fishing Boat for the Malaysian Market

Summary of Malaysian History

Malaysia has a strong maritime tradition because of its large coastal area. It is the southernmost projection of Asia and therefore became part of the trading history of civilizations to the east and west. The Proto Malays migrated into peninsular Malaysia from the Indonesian archipelago. Indians were the first regular traders with Malaysia and this influence appears in the Malay language and the rise of Hinduism throughout the Malay World most vividly expressed by the Borobudur temple in Java. The first large scale organized culture to influence the Malay people was the Srivijaya empire founded in Sumatra. By the 14th century, the ascension of the Thai empire diminished the Srivijay's influence. However Paramewsara, a Javanese prince, set up a principality in Melaka on the west coast of peninsular Malaysia and allied himself with China as a foil against the dominance of Thai empire. Melaka was used by the Chinese as a trading port and was heavily involved in trade with India. Until the Portuguese arrived in the 15th century, the Melaka kingdom under Chinese protection, controlled much of the trade in Southeast Asia and was able to fend off Thai advances. In 1511, the Portuguese defeated the Sultan of Melaka and governed this area for 130 years. The Dutch defeated the Portuguese in Melaka in 1641 and maintained control for over 180 years until the British and Dutch signed an agreement in 1824, establishing peninsular Malaysia under British governance and Indonesia under the Dutch. Subsequently, the Malaysian peninsula was influenced by Proto-Malays, Indians, Arabs, Chinese, Sumatrans, Javanese, Portuguese, Dutch and British. Northeastern peninsular Malaysia was influenced by Thailand and was governed by Thailand until 1909.

In Malaysia, large scale ethnic identity exists. The political parties are also rooted in ethnic identity. The Malays are the largest and politically dominant group while the Chinese are traditionally the most economically prosperous. The Chinese (mainly from southern China) were brought into Malaya to work the tin mines, while the Indians (principally Tamils) immigrated to work the rubber plantations. The southern Chinese dialects are still spoken among the Chinese, along with the more universal Mandarin. Tamil is spoken among the Indian Malaysians. The Indians are not connected with the fishing industry in any way while the Chinese are very involved on the west coast (Strait of Malacca) and the southeast coast (South China Sea).

Many recent historical issues mingle into the ethnic politics. The Chinese were most active in resisting the Japanese during World War II and they bore the brunt of Japanese atrocities. The resistance movement morphed into an anti-British Chinese communist insurgency that did not cease until the 1970s. The separation of Singapore in 1965 was also related in part to ethnic politics because it reduced the Chinese population to below the Malay population. The peaceful separation of Singapore assured Malay dominance.

Overview of Malaysian Fishing Boats

Fishing vessels are licensed for certain types of operations coded as Class A, B, C and C2. Class A boats cannot use trawling or seine nets and are generally below 40 GRT (gross registered tonnage). These boats typically use hooks on fishing lines, gill, lift and push nets and normally fish near rivers and coastal areas within 25 nautical miles of shore. Class B boats are trawlers and purse seiners less than 40 GRT and must operate at least five nautical miles offshore, although they can seek special licensing to allow them to fish for prawns within five nautical miles. Class C boats must operate beyond 12 nautical miles from shore and are trawlers and purse seiners between 40 and 70 GRT. Class C2 must operate beyond 30 nautical miles in Malaysia's Exclusive Economic Zone (EEZ) zone.

Malaysian fishing boats are typically made from *chengal (neobalenocarpus heimi)*, a rot and marine borer resistant tropical hardwood. Alternative spellings of chengal include cengal and chengi.

Overview of Fishing Environment

Tropical fish are generally non-schooling type; however, *kembong, tamban* and *tongkol* do form small schools. Therefore large hauls are not possible without fish aggregating devices for pelagic fish. Fisheries tend to have a higher density near the coast. Fishes of particularly high value are red snapper, grouper, horse mackerel, Indian threadfish and Spanish mackerel.

The two areas of fishing in peninsular Malaysia are the South China on the east coast and the Strait of Malacca on the west coast. The South China Sea rarely exceeds Sea State 4 and the Strait of Malacca are usually calmer. The water around peninsular Malaysia is shallow, resting on a continental shelf less than 200 meters deep. Estuaries are used for harboring boats and these are shallow and unless dredged, produce steep waves. Fish landings decrease significantly with increasing wave height associated with the monsoons. During the monsoon season only about 30 percent of east coast fishermen continue fishing.

Overview of Malaysian Fishing Technology History

The key events affecting fishing technology are 1) the introduction of purse seining and mechanization in 1930, 2) the introduction of synthetic material for nets in 1960, and 3) introduction of trawling.

The introduction of purse seining obsolesced smaller netting and trapping technology. Purse seiners are thought to have been introduced by immigrants from south China. The increasing catch led to the introduction of refrigeration technology to preserve the catches. The additional weight of nets and refrigeration system led to the use of small (8-20 HP) engines in the 1930s.

The introduction of trawling is thought to have been initiated on the west coast in Pangkor and was influenced by the success of Thai fishermen in the mid-1960s. Initially 10 boats were converted in July 1966 and by December 1966, 40 trawlers were in operation. The technology was quickly adopted and by 1974 trawling accounted for 34 percent of the total catch. By 2004 trawlers produced 56 percent of the fish. This percentage has remained unchanged since 1996.

Design Brief

Due to decreasing availability of chengal and the Malaysian government's interest in modernization, you have been asked to design a new fishing boat with the following requirements:

1. Accommodate a crew of four (this includes skipper).
2. Class B operation.
3. Constructed with a more sustainable material than chengal.
4. Appropriate for drift/gill nets, trawl nets, as well as hook and line with minor modifications.
5. Acceptable to traditional Malaysian fishermen.

Presentation Structure

The case presentation must include identification of the physical, social and cultural environments governing the boats design and operation.

Present the case with the following structure:

- Summary of design brief.
- Description of research methods if time and money are unconstrained.
- Description of research methods if using only those at your institution.
- Supporting research data.
- Supporting assumptions.
- Identify three design concepts.
- Develop one of these designs into a concept drawing.

Appendix 8

Malaysian Class B Fishing Boat Concept

Conceptual Design Specifications

LOA:	14.3 m
LWL:	12.3 m
BWL:	4.5 m
Draft/Draught:	1.6 m
Depth Moulded:	2.1 m
Displacement:	29 MT
Cp	0.63

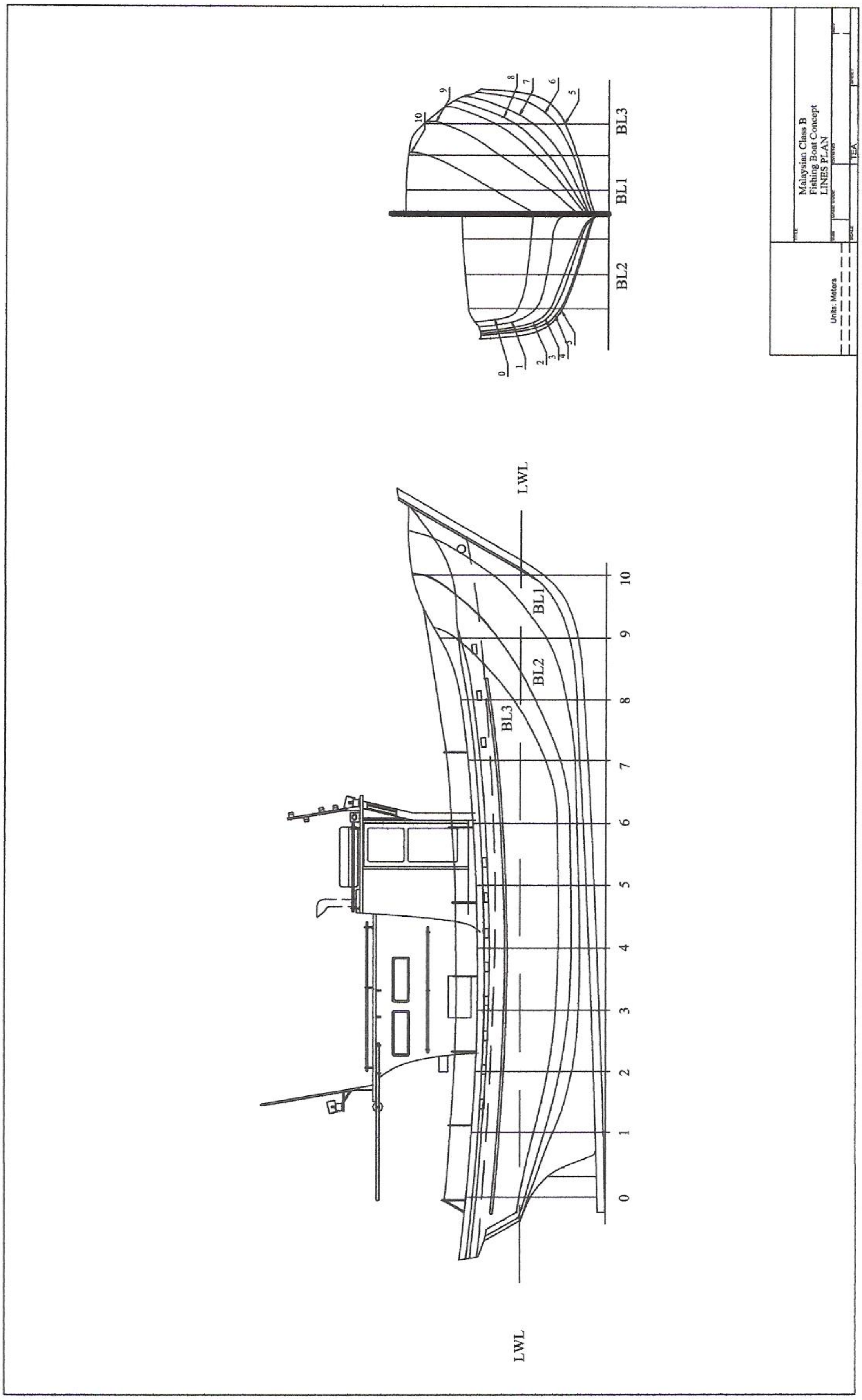
Key Boat Features

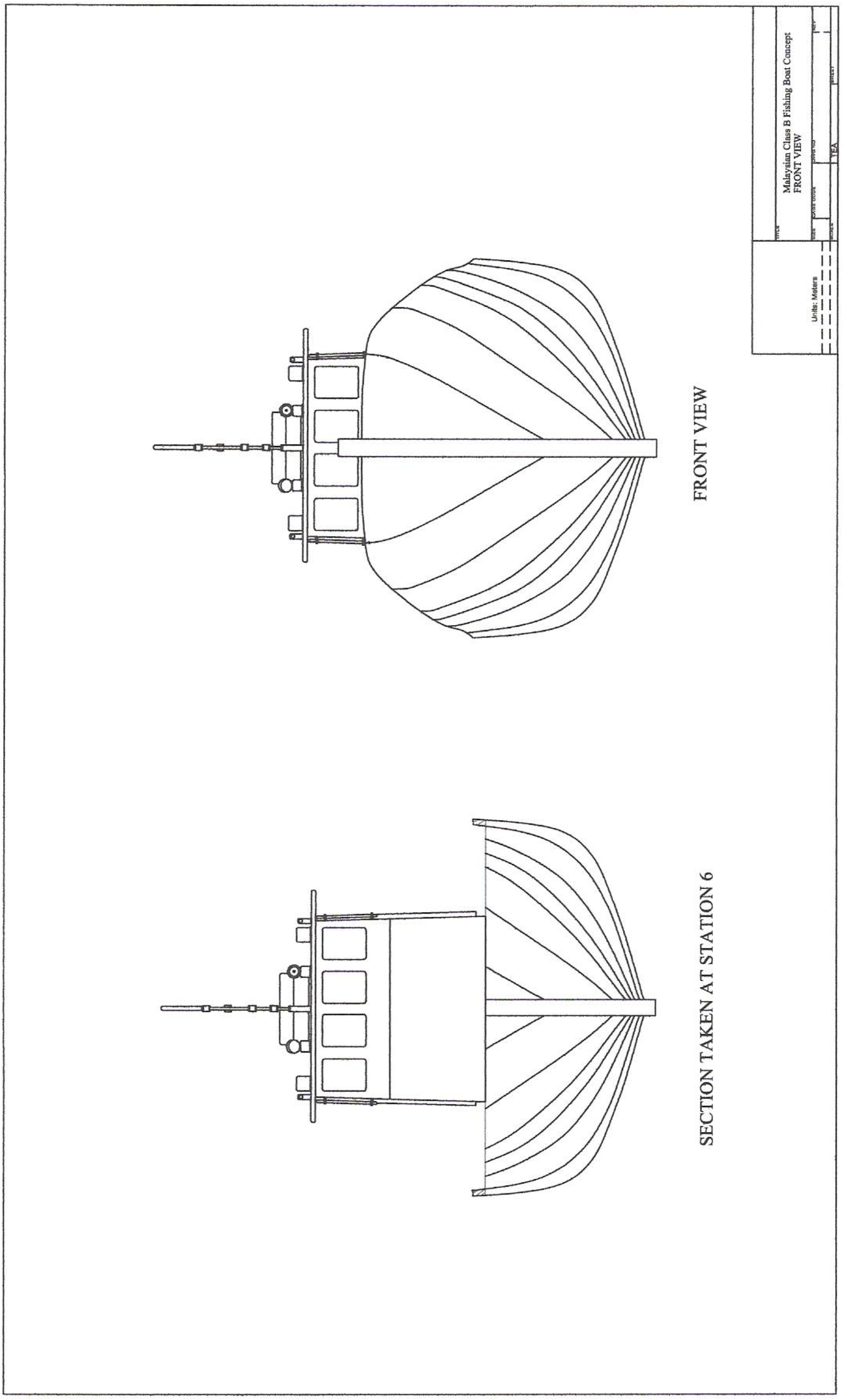
A description of the design is offered in fuller detail in Chapter 5.

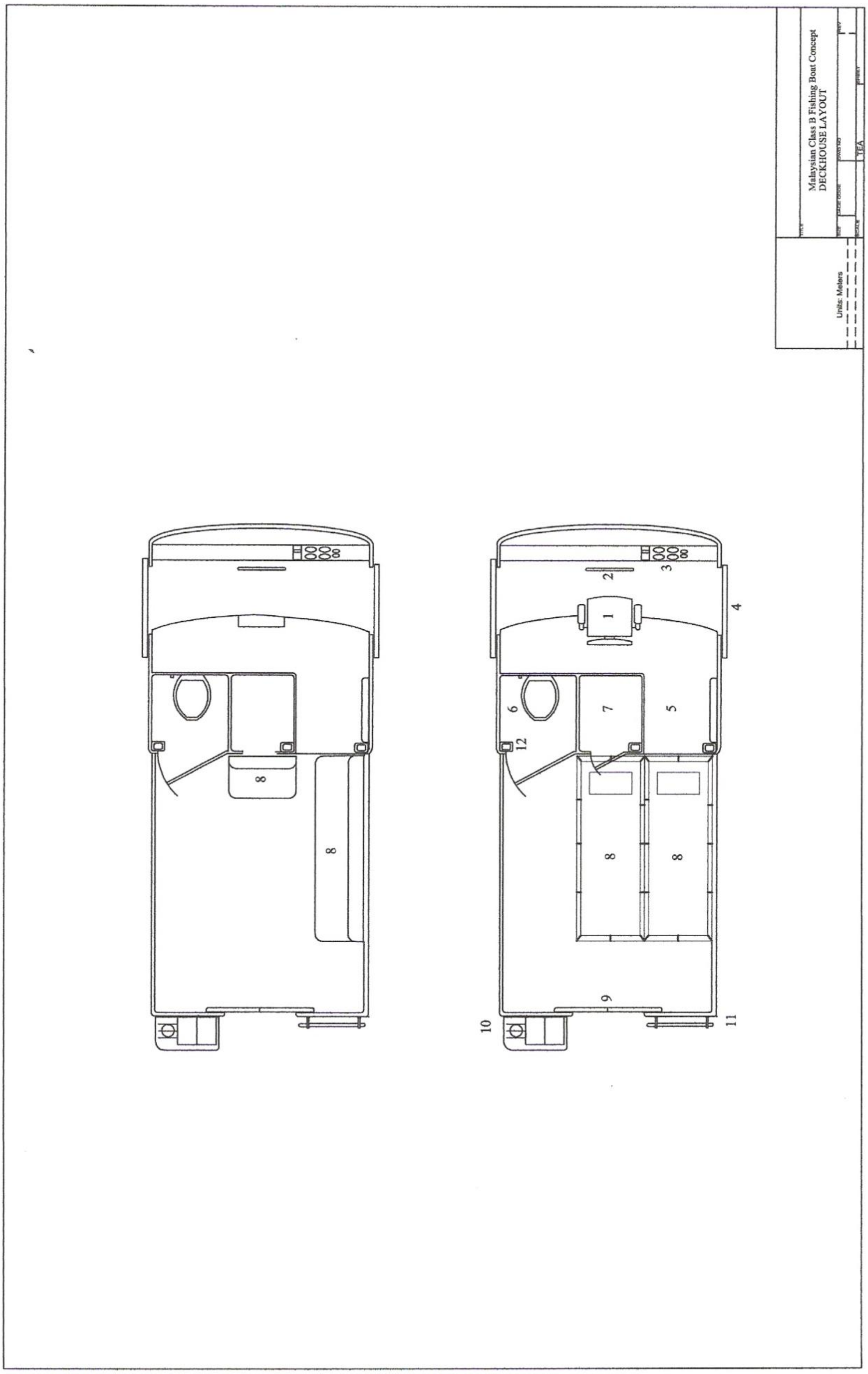
- Deck hardware includes stainless steel chocks, two at bow, two at stern, four amidships, behind the freeing ports, and a forward bollard.
- Bulwarks include freeing ports.
- Deck is cambered to aid in drainage.
- Railing encircles the deck except at the stern.
- Fish holds are refrigerated and insulated with a seven ton capacity. Refrigerant leak detection alarm.
- Two electric and one manual bilge pumps. Bilge alarm.
- Watertight hatches.
- Engine: diesel, dry exhaust with inline muffler.
- Fuel Capacity is 3500 liters comprised of two tanks with one centerline day tank and duplex filter.
- Water Capacity: 1500 liters
- The deckhouse is divided into a forward pilot house module and an after deckhouse.
- Pilot house module contains: helm chair, engine controls and gauges, toilet, engine exhaust casing or waterproof locker, life raft, navigation lights, spot lights, horn, antenna and hardened mounting pad.
- Deckhouse contains berths, seating, sink, stove and retractable shade cover.

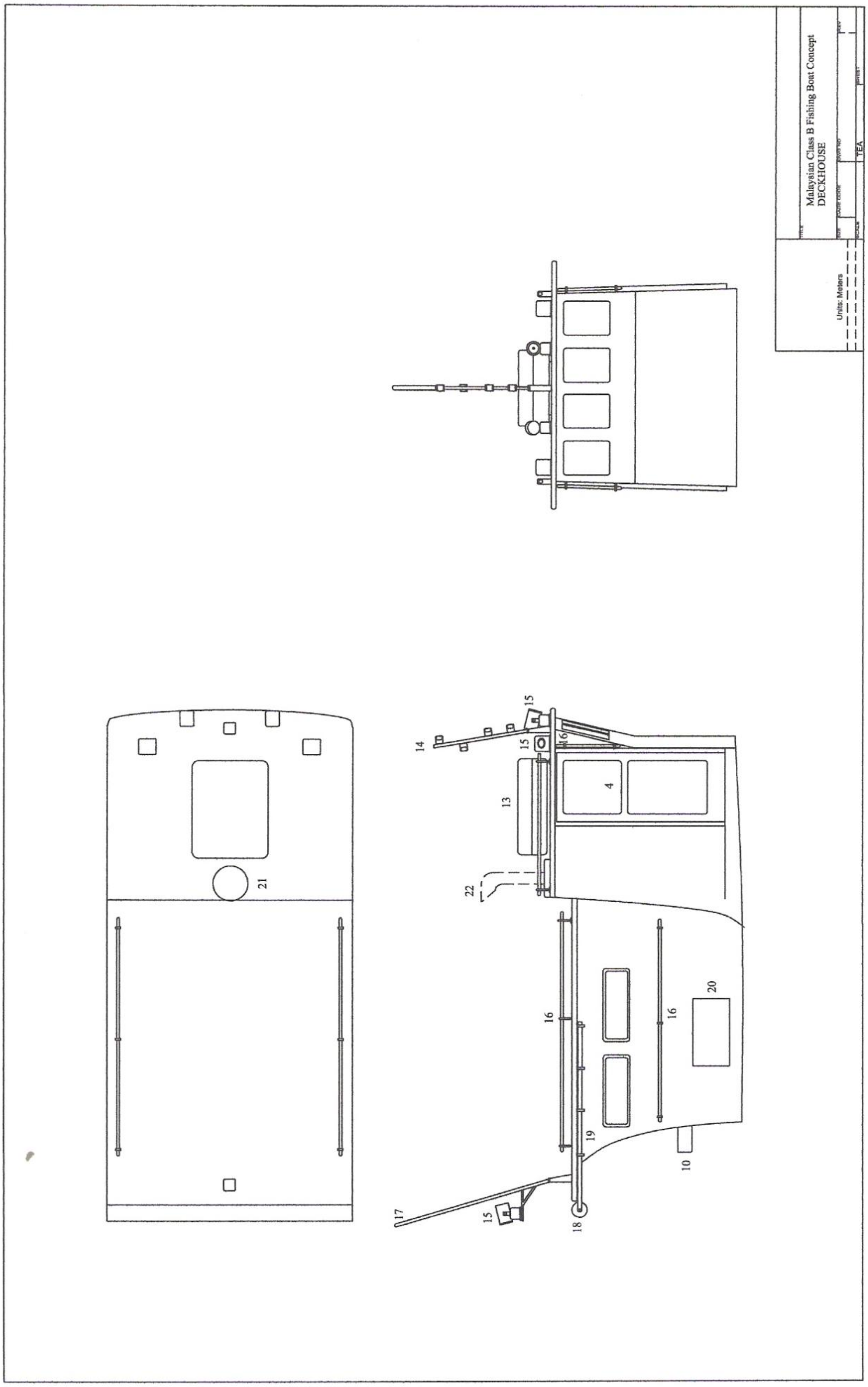
Drawing Key

1	Helm Chair
2	Wheel
3	Throttle and instrument
4	Pilot house door
5	Pilot house crawlway
6	Toilet
7	Dry storage
8	Berth (convert to settee and chair)
9	Deckhouse doors
10	Sink and stove
11	Grab rail/boot hanger
12	Arch support (tubing cross section)
13	Life raft
14	Navigation lights
15	Spot light
16	Grab rail
17	Ensign/radio mast
18	Sun screen roller
19	Sun screen support rod
20	Engine access panel
21	Attachment pad (movable athwartship)
22	Dry exhaust (if routed through pilot house module)


Malaysian Class B
Fishing Boat Concept
LINES PLAN
TEA
Units: Meters
BL1
BL2
BL3
LWL
LWL
0
1
2
3
4
5
6
7
8
9
10


Malaysian Class B Fishing Boat Concept
FRONT VIEW
TEA
Units: Meters
FRONT VIEW
SECTION TAKEN AT STATION 6


Malaysian Class B Fishing Boat Concept
DECKHOUSE LAYOUT
Units: Meters
YEA


Malaysian Class B Fishing Boat Concept
DECKHOUSE
Units: Meters
TEA
14
15
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13
4
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19
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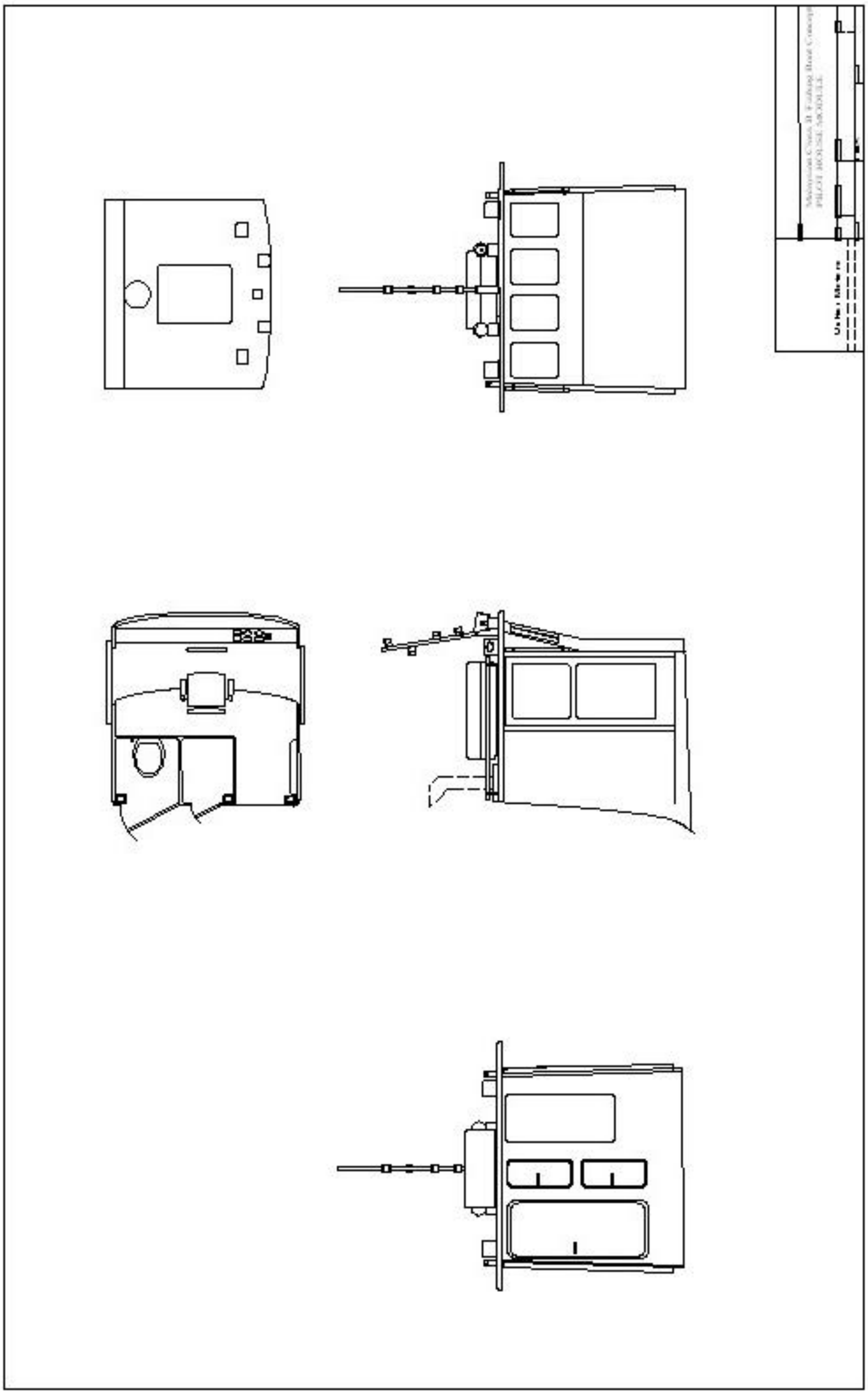
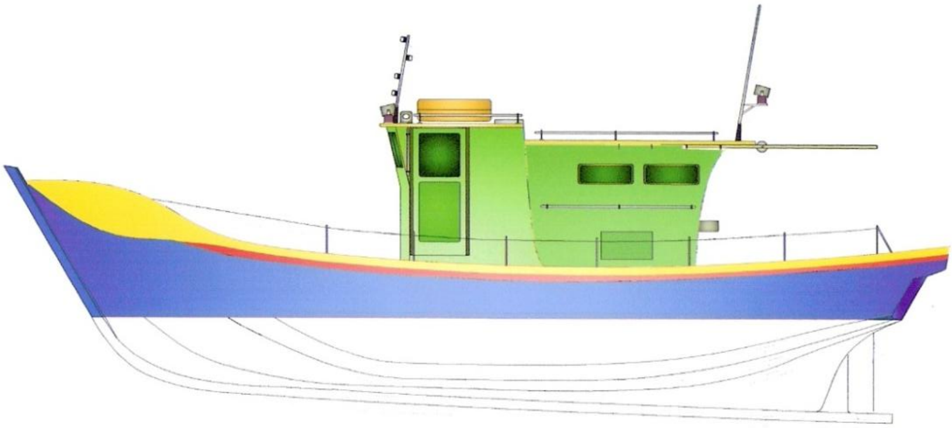
17
15
18





Color scheme portrayals above the waterline with green Terengganu deckhouse color